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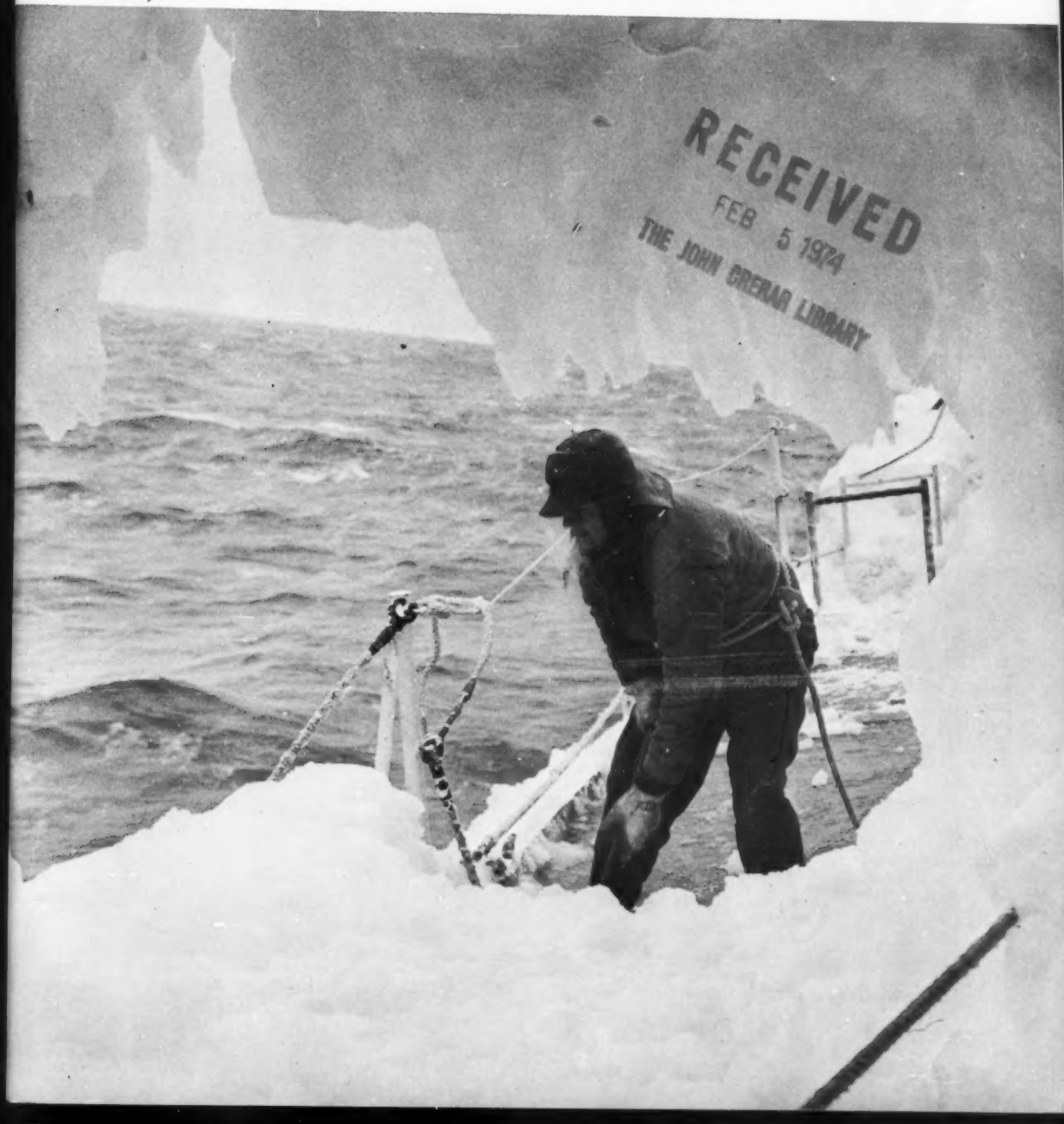
National Oceanic and Atmospheric Administration • Environmental Data Service



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Mariners Weather Log

Editor: Elwyn E. Wilson

Editorial Assistant: Nancy L. Westrell

January 1974
Volume 18 Number 1
Washington, D.C.

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Cover: Searching for a victim of superstructure icing, the Coast Guard Cutter CASTLE ROCK ran into this same problem--and took on 300 tons of unwanted ice. See story opposite. U.S. Coast Guard Photo.

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The Secretary of Commerce has determined that the publication of this periodical is necessary in the transaction of the public business required by law of this Department. Use of funds for printing this periodical approved by the Director of the Office of Management and Budget, July 26, 1973.

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MARINERS WEATHER Log

SUPERSTRUCTURE ICING

Richard M. DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

Beneath the overcast, gales lathered the icy seas of the Denmark Strait. Norman Trolle shivered as the cold morning light played across the ice-encrusted bow of his fishing trawler. He needed no forecast to tell him that he and his crew were in for a third consecutive day of extreme cold and high winds. He logged the KINGSTON GARNET's condition on that January day in 1955: "Shrouds and ratlines all in one, masts and halyards solid, radar tower frozen over, boats' davits and all boats frozen solid, funnel frozen all round, handrails a solid sheet of ice, clear view screen solid, on the fore side of the wheelhouse the windows carried 4 in of solid ice."

Captain Trolle didn't know it at the time, but he was lucky, for less than 100 mi to the north, crewmen aboard the fast-icing LORELLA were battling for their lives. For them, there was no running, no calling for help. All they could do was hold the trawler's head to the wind and wait for the weather to break. There was no break. Near hurricane-force winds carried sea spray from atop 30-ft seas and dumped it on the weakening trawler. In a few hours, tons of ice coated the upper superstructure. The hull plates were continuously washed clean by the sea, so that the ship was becoming topheavy. The pounding was relentless. Finally, the ship became unmanageable. Her head fell away from the wind. With the tremendous increase in sail area provided by the ice, the LORELLA was about as stable as a full-rigged sailing ship in a hurricane. She went down with all

Figure 1.--Up to 10 in of ice cover the USCGC OWASCO after battling gales and rough seas at Ocean Station "Bravo." U. S. Coast Guard Photo.

hands. Less than 5 mi away, this scene was being repeated at the expense of the RODERIGO.

If you've regularly sailed or fished cold seas in winter, you have probably run up against some type of superstructure icing. On big merchant ships, it usually means no more than slippery decks, since they have a high freeboard and pass quickly through icing conditions. Fishing trawlers, small merchant ships, and Coast Guard cutters are another thing altogether (fig. 1). Their freeboards are relatively low. A trawler often has a large top hamper and is usually confined to one area for long periods. On a small ship, icing can greatly increase the weight. It elevates the center of gravity, which decreases the metacentric height. It increases the sail area and heeling moment due to wind action. The trim is changed, owing to the nonuniform distribution of ice. Icing hampers steerability and lowers ship speed. In short, superstructure icing tolls a potential death knell for fishing vessels and other small ships. Icing may also cause problems for stationary platforms such as drilling rigs.

Sinkings caused by superstructure icing are not freak occurrences. Wherever winter winds howl and temperatures of air and sea are low, icing disasters can occur. During a recent 5-yr period, ice accretion has sent 19 Japanese fishing vessels and nearly 300 crewmen to icy graves in the waters around Hokkaido, Sakhalin, and the Kuril Islands. On January 25, 1957, the Danish naval cutter TERNEN iced up heavily on the fore deck and port side. She went down off Ravns Storo, Greenland, rolling over so quickly that two of the crewmen were trapped in the galley. The other six were never found.

Off Newfoundland, on February 8, 1959, icing caught both the Icelandic steam trawler JULI and a Canadian fishing vessel. Both went down. Again off Newfoundland, in February 1966, the BLUE MIST II iced up and sank with a crew of 13. On December 2, 1970, the fishing vessel ANDREA iced up in a storm off the coast of Alaska. Listing badly, the ship was beached. The eight people aboard, including a 6-mo-old baby, were never heard from.

Captain Alexander of the U.S. Coast Guard is a man experienced in the problems of superstructure icing. He feels the way to beat it is to understand the hazard, in order to act quickly. Ice accretion is a complex process that depends on sea conditions, atmospheric conditions, and the ship's size and behavior. Icing can be caused by heavy sea spray, freezing rain, or fog.

Freezing sea spray is by far the most common and dangerous form of icing. It can occur when the air temperature falls below the freezing temperature of seawater (usually about -2°C) and sea-surface temperatures are below about 5°C. If air temperature falls below about -18°C, wind-induced spray may freeze before striking the ship and not adhere. In general, however, the lower the temperature and the stronger the wind, the more rapid the accumulation of ice.

It was estimated that the LORELLA (559 tons) and the RODERIGO (810 tons) accumulated more than 50 tons of ice in less than 24 hr before they went down. During this period, they encountered air temperatures of about -4°C and winds up to 60 kt.

Tests by the Russians, Japanese, and British have shown that when air temperatures are just below the freezing point of the seawater, ice buildup is slow, and will not accumulate at more than 1 ton per hour on a 300- to 500-ton vessel, in any wind. On a vessel of this size, a moderate buildup of less than 4 tons per hour will generally occur with air temperatures between -3°C and -8°C, in winds of 16 to 30 kt. When winds exceed 30 kt and temperatures drop below -8°C, conditions are right for an accumulation rate of more than 4 tons per hour on a 300- to 500-ton vessel. These figures are somewhat subjective, and represent a compromise of opinions of the major maritime nations.

A ship can also encounter icing in freezing rain or a type of fog often called "steam fog." Freezing rain can coat a ship with a freshwater glaze ice the same way it covers trees and roads on land. The weight picked up is usually not enough to endanger a ship, but this ice can make topside conditions dangerous. Steam fog can occur when the air temperature is below freezing and is also considerably colder than the sea. It is usually confined to a layer a few feet thick. Trawlermen call it "white frost" when the top of the layer is below the observer's eye level and "black frost" when it extends above the observer. The small water droplets in this fog are supercooled (exist as water even though the temperature is below freezing) and freeze on contact with the cold ship. Usually, ice accretion by this method is small (fig. 2). However, there are exceptions. The ERNEST HOLT, about 100 mi east of Bjørnøya Island (an island north of Norway) and 20 mi from the ice edge, ran into a dense steam fog. She took 4 in of rime ice on the deck, with up to 12 in on the ship's side at the level of the rail, within a 12-hr period.

Superstructure icing can occur in the cold water seas of both hemispheres, from fall through spring. In the North Atlantic region, figures 3 and 4 show which areas are prone to potential icing conditions. The two categories of potential icing are somewhat subjective, but give a relative idea of which areas are dangerous. Moderate icing potential exists when temperatures fall to -2°C or below and winds blow at 13 kt or more. This means a probable accumulation of up to about 3 in per hour. The potential for severe icing (greater than 3 in per hour) exists when temperatures are -9°C or lower, and winds are 30 kt or more.

Superstructure icing in the North Atlantic region is mainly a problem from November through April, although it has been reported in all months except July, August, and September. January and February are the worst months; the potential for moderate superstructure icing exists more than 30 percent of the time in the waters around Nova Scotia and Newfoundland, in the Labrador Sea, the Davis Strait, the Denmark Strait, the northern Norwegian Sea, and the Barents Sea. Severe icing is a threat mainly in January and February, and then mostly in the Labrador Sea and the Davis Strait. Frequencies for severe icing potential in these waters range from 2 to 6 percent. Fortunately, in seas where winds are consistently strong, the air and sea are relatively warm due to the Gulf Stream; in areas where temperatures are consistently frigid, like the Barents Sea, winds are moderate.

Although superstructure icing is dangerous to small ships, it is not always fatal, particularly if the

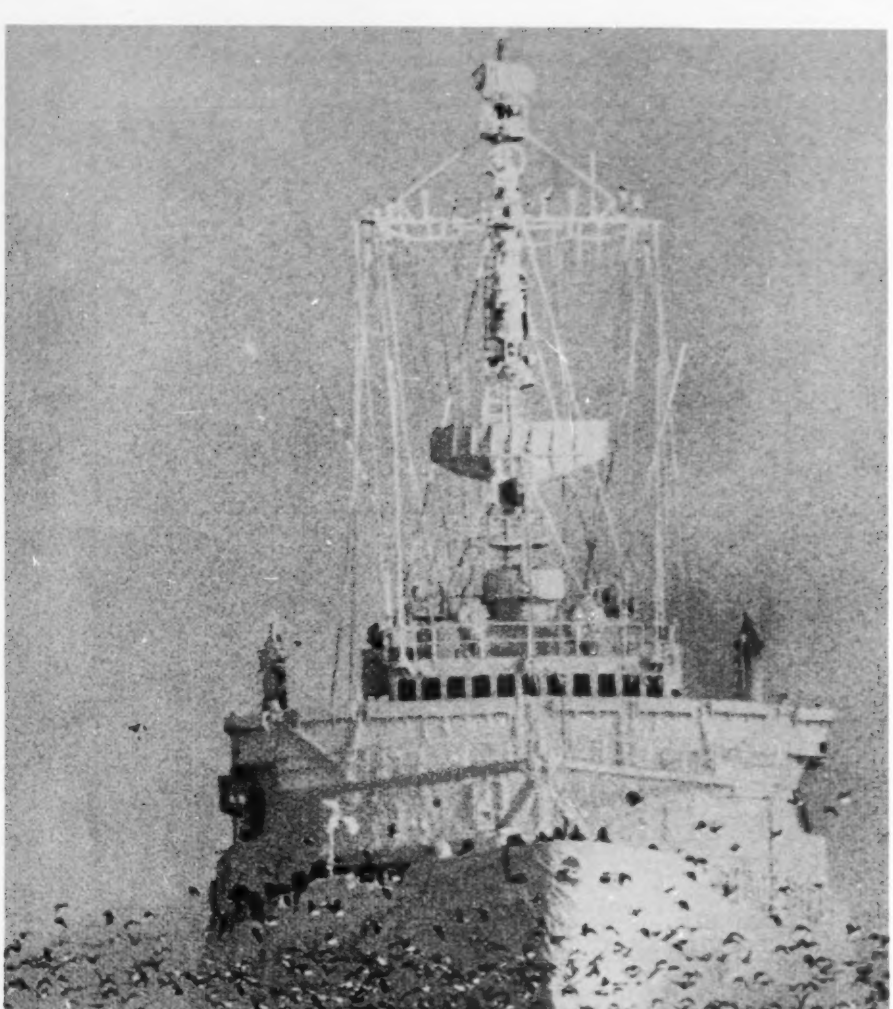

Figure 2.--The ice-encrusted icebreaker EDISTO accompanies a flock of ducks through some "black frost" on the Great Lakes. United Press International Photo.

captain is knowledgeable about the hazard. The noted scientist-explorer Jacques Cousteau and his 29-man crew avoided near disaster aboard the CALYPSO in dangerous Antarctic waters last year. His 141-ft vessel had been crippled by a block of ice and was layed up in Hope Bay opposite King George Island. Winds were howling at 45 to 80 kt, creating blizzard conditions. Cousteau recalls: "By the time we sought shelter, there was 30 tons of ice hanging on the ship. We would have been lost without the shelter of that island."

Marine forecasts also contain information on potential icing conditions. With the help of these warnings, you can often avoid icing altogether. In the tragic case of the ANDREA, which iced up off Alaska, heeding the forecasts could have prevented the disaster. At the time of her departure from Juneau, winds were light, seas were moderate, and air temperatures were running around -10°C. The forecast was for winds of 50 kt or more, with temperatures dropping to around

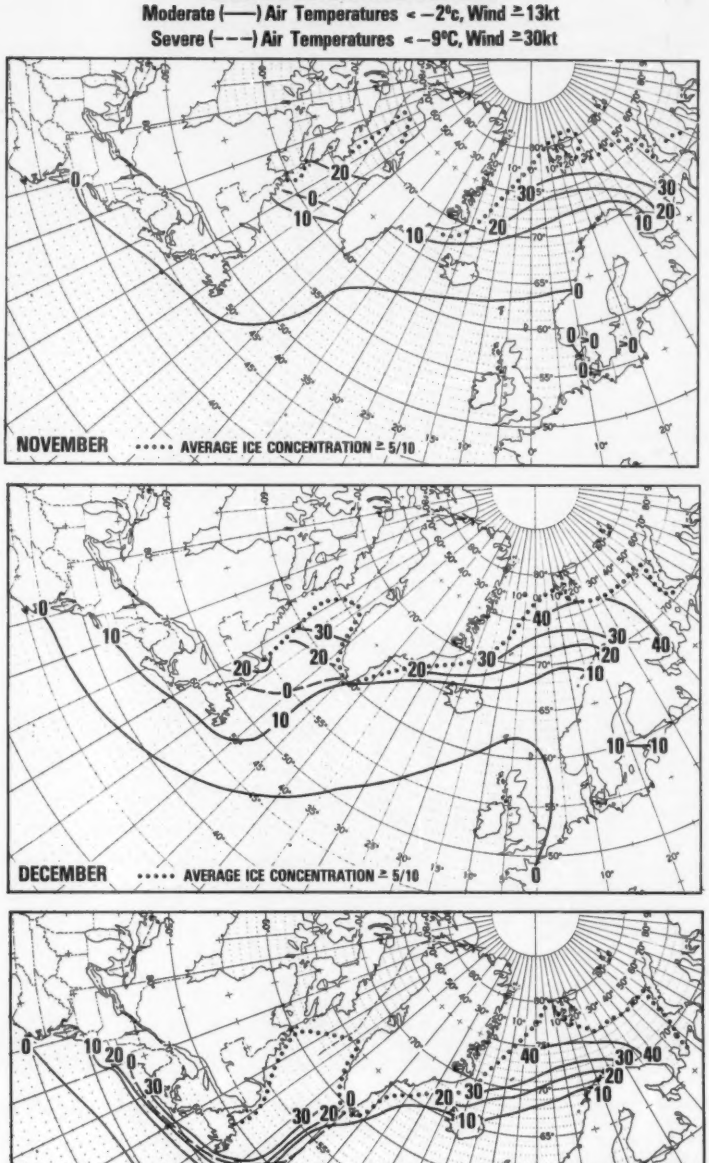
POTENTIAL SUPERSTRUCTURE ICING
Moderate (——) Air Temperatures ≤ −2°c, Wind ≥ 13kt
Severe (– – –) Air Temperatures ≤ −9°C, Wind ≥ 30kt
NOVEMBER ····· AVERAGE ICE CONCENTRATION ≥ 5/10
DECEMBER ····· AVERAGE ICE CONCENTRATION ≥ 5/10
JANUARY ····· AVERAGE ICE CONCENTRATION ≥ 5/10

Figure 3.--Moderate and severe potential superstructure icing for North Atlantic Ocean, November, December, and January.

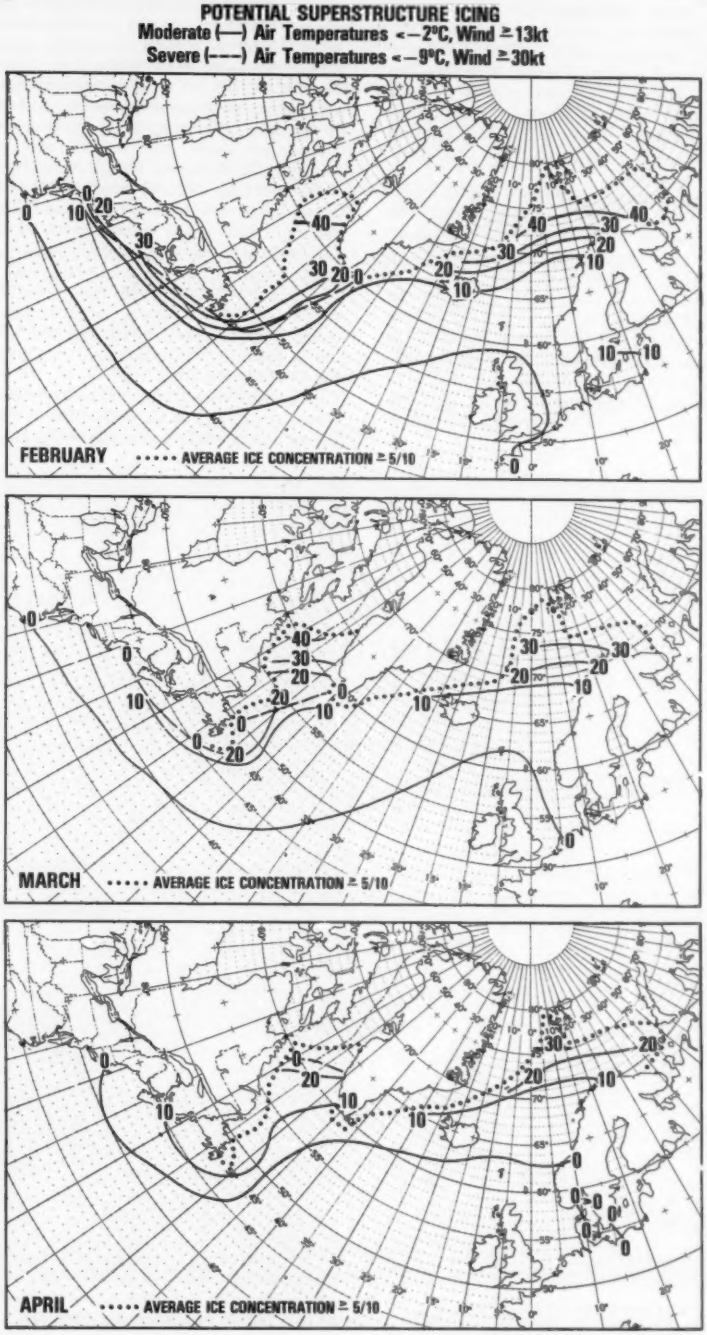
POTENTIAL SUPERSTRUCTURE ICING
Moderate (—) Air Temperatures ≤ −2°C, Wind ≥ 13kt
Severe (- - -) Air Temperatures ≤ −9°C, Wind ≥ 30kt
FEBRUARY ····· AVERAGE ICE CONCENTRATION ≥ 5/10
MARCH ····· AVERAGE ICE CONCENTRATION ≥ 5/10
APRIL ····· AVERAGE ICE CONCENTRATION ≥ 5/10

Figure 4.--Moderate and severe potential superstructure icing for North Atlantic Ocean, February, March, and April.

-15°C; conditions right for severe icing.

When potential icing conditions are present or forecast, warmer areas or protected ports are the best insurance. As Cousteau knew, it helps to know the location of sheltered coastal areas. The location of warmer currents is also a help, since they usually mean warmer air temperatures. Shelter in the lee of an ice edge is particularly dangerous. Here air and sea temperatures are often coldest, and a wind shift could leave the ship exposed.

A ship's own observations are another way to check on the threat of icing. If icing is encountered, the buildup rate is a tipoff as to the severity. A rate of up to 3 in per hr can usually be tolerated for a short period. Anything greater than this can quickly create stability problems. The BIBB ran into an icing situation which lasted for 6 hr. A 1-in manila line acquired a sheath of ice that measured 20 in in diameter. Ice deposits on the deck and superstructure indicated a buildup rate of between 3 and 4 in per hr. The vessel's course was directly into the sea and spray, so she iced up evenly and showed no list.

Icing rates can be cut by slowing down to reduce ship-generated spray. A course change to reduce spray, however, should be secondary to getting away from the icing, except in critical conditions. Another precaution is to remove the ice, if possible. Aboard the USCGC OWASCO, deck crews used baseball bats, hammers, pick handles, axes, and shovels to break up the ice, which they then dumped overboard (fig. 5). They also used hot water from the engineroom. However, this tactic could backfire. The TAHOMA, while battling severe icing in the Davis Strait, was using saltwater heated by steam injection to help melt the ice. The rapid consumption of feed water nearly immobilized the propelling machinery of the badly listing vessel. When icing becomes a problem, it is important to first free the aerials, freeing ports, stays, shrouds, masts, rigging davits running and navigational lights, windlass, and hawsepipes. If the ice is unevenly distributed, it should be removed from the listing side first.

The Russians are well experienced with superstructure icing, as they do a lot of cold water fishing. From a proposal they made to the Inter-Governmental

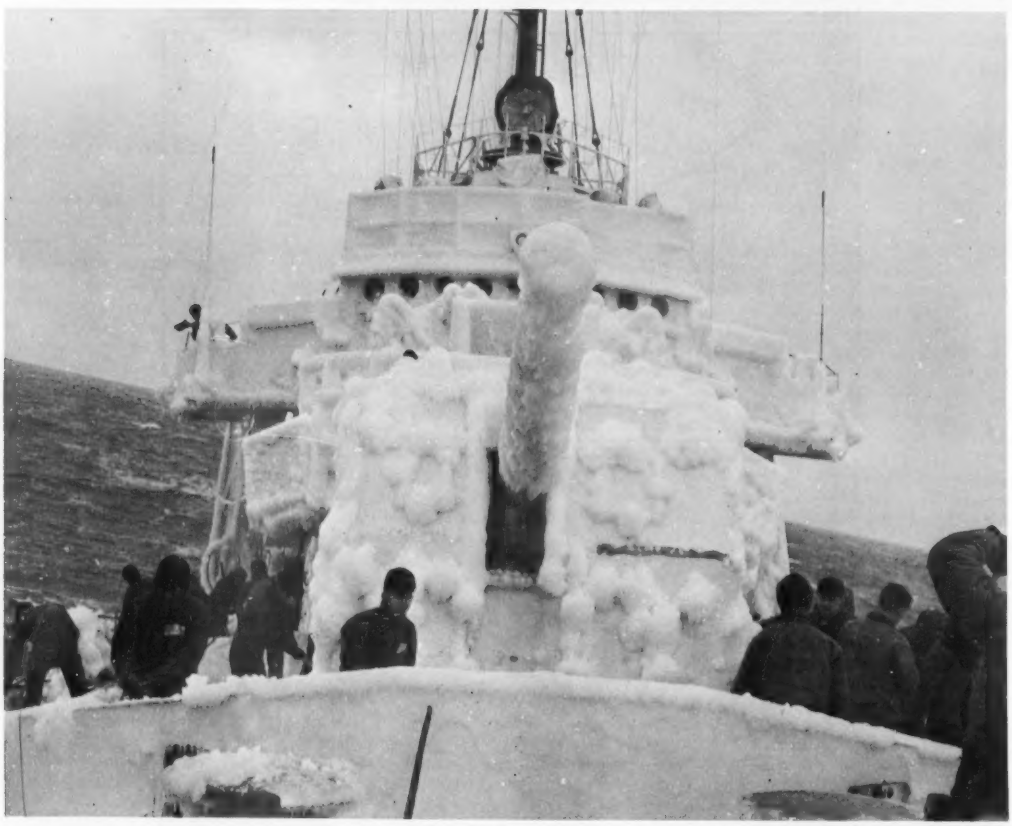

Figure 5.--Ice removal system aboard the USCGC OWASCO. What a difference (see fig. 1) a good crew makes. U.S. Coast Guard Photo.

Maritime Consultative Organization (IMCO), we have excerpted, in table 1, excellent suggestions of what to do in an icing situation.

Table 1.--Tips to keep icing hazards a minimum aboard fishing vessels

1.	Head for warm water or protected coastal areas.
2.	All fishing gear, barrels, and deck gear should be placed below deck or fastened to the deck as low as possible.
3.	Cargo booms should be lowered and fastened.
4.	Deck machinery and boats should be covered.
5.	Storm rails should be fastened.
6.	Gratings should be removed from scuppers, and all objects that might prevent water drainage from the deck should be moved.
7.	Ship should be made as watertight as possible.
8.	If freeboard is high enough, all empty bottom tanks containing ballast piping can be filled with seawater.
9.	Reliable two-way radio communication should be established either with a shore station or another ship.

The LORELLA and RODERIGO were alone in an icy world during their final hours. Survival was entirely in their own hands. The loss of these ships and others has made it clear to the major maritime nations that help is due these fishermen who risk their lives during winter. As a result, England now has a government ship stationed in the Icelandic fishing grounds to offer aid and provide icing warnings. Germany also provides a mother ship for her fishing fleet. There is talk of establishing long-overdue assistance on an international scale.

The 4,555-ton German freighter ELSFLETH was on a run from Bremerhaven to Baltimore in February 1968. On the 18th, near the Labrador current, air temperatures fell sharply from 5°C to -4°C, while water temperatures dropped to near zero. Winds were already above 20 kt. The sea spray that broke across the bow began to freeze. The ship iced up quickly. Soon, ice on the glass bridge windows froze hard. In the bitter cold, the ship had to be steered from the lee bridge. Captain Sachse later recalled: "Thank God the visibility was always good and both radars were working well." Ice continued to accumulate as temperatures dropped to as low as -8°C. By early on the 22d, the ice was nearly 12 in thick on the foreship and 4 in thick on the bridge, bulkhead, and quarterdeck. The total accumulation was estimated at between 300 and 400 tons. The situation was becoming serious. Captain Sachse remembers: "The stability of the ship was poor, because of that (ice), but by flooding the double tanks with 550 tons of ballast, this was improved." He also steamed for the warmer waters (2°C) of the Gulf Stream, and his crew helped remove the ice with hammers, axes, and shovels. These decisive actions saved the ship and crew from an icy grave in the North Atlantic.

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NORTH ATLANTIC TROPICAL CYCLONES, 1973

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National Hurricane Center, NOAA
Miami, Fla.

In contrast to the 1972 hurricane season, when only limited areas of North Atlantic waters were affected by tropical cyclones, figure 6 shows that relatively few areas failed to come under the influence of at least one storm or hurricane during 1973. For the first time since 1966, tropical cyclones of storm strength developed in the far eastern Atlantic. The total of seven tropical cyclones, of which four were hurricanes, was below the 30-yr averages of ten and six, respectively. Tropical cyclones of hurricane intensity were in existence on 13 days, with a ship reporting winds of hurricane force in Brenda and Fran.

Figure 7 shows the tracks of subtropical cyclones of 1973. This type of storm was discussed in an article in the July 1973 issue of the Mariners Weather Log. Hurricane Fran evolved from a subtropical cyclone in a manner similar to Betty of 1972. However, for the first time of record, a tropical storm--Gilda--weakened to a depression and then was rejuvenated as a large, severe type A subtropical cyclone. Marine advisories were issued for tropical storm Gilda during its subtropical existence.

Summaries of the North Atlantic tropical and subtropical cyclones are given in tables 2 and 3 respectively. Summaries of extratropical portions of these cyclones, if severe, can be found in the appropriate Smooth or Rough Log.

The National Hurricane Center (NHC) in Miami, Fla., wishes to express its continuing appreciation for the numerous ship observations received during tropical and subtropical cyclones. With four of the storms moving across the primary North Atlantic shipping lanes, many vessels were affected. Table 4 lists those ship observations of winds $\geq$ 34 kt and high waves ($\geq$15 ft) received, plotted, and used during the issuance of bulletins and advisories. Some ships were unidentified, and perhaps others had call letters scrambled during communications, but vessels and crews who were at the positions indicated knew, indeed, if they were unfortunate enough to be there. Some of these and other ship weather observations received during developing stages of the cyclones are included in individual storm writeups.

Table 2.--Summary of North Atlantic tropical cyclone statistics, 1973.

No.	Name		Dates	Maximum Sustained Winds (kt)	Lowest Pressure (mb)	U.S. Damage ($ Millions)	Deaths
1	Alice	(H)	July 1-6	80	986		
2	Brenda	(H)	Aug 18-22	70	977		Mexico - 10
3	Christine	(T)	Aug 25-Sept 4	62	996		P.R. - 1
4	Delia	(T)	Sept 1-7	60	986	18.0*	U.S. - 5
5	Ellen	(H)	Sept 14-23	120	962		
6	Fran	(H)	Oct 8-13	70	978		
7	Gilda	(T)	Oct 16-29	50	994	#	

* $15 million of this amount was crop damage resulting from heavy rains with Delia and a tropical depression, which affected the same area 5 days later.

\# An undetermined amount of beach erosion was caused mainly by the subtropical storm which developed from Gilda.

Table 3.--Summary of North Atlantic subtropical cyclone statistics, 1973

No.	Name	Dates	Maximum sustained winds (kt)	Lowest pressure (mb)
1	Alfa	July 30-Aug 1	40	1005
2	Bravo (Fran)	Oct 8-9	60	998
3	Unnamed (Gilda)	Oct 24-27	60	980

HURRICANE ALICE, JULY 1-6

Hurricane Alice was the first hurricane or tropical storm of record to ever develop or pass near Bermuda in early July. The initial development of the LOW which became Alice resulted from the interaction of an easterly wave with a large convective cloud system moving eastward from Florida and the western Bahamas. A report by the CHARLESTON of southerly 20-kt winds and 12-ft swells, near 24°N, 68°W, at 1200 on June 30, helped confirm the existence of a well-defined 1012-mb center near 26°N, 69°W. Twelve hours later, the CHARLESTON had passed through the LOW and reported 15-kt northeasterly winds near 28°N, 69°W.

The depression gradually strengthened during the next 48 hr, as it turned to a northerly course on the western periphery of a large HIGH centered near 40°N, 47°W. The CHOLUTECA reported east-northeasterly 30-kt winds near 27°N, 68°W, on the morning of July 1, but tropical storm strength was not attained until late on the 2d, when the LOW had reached a pressure of 1005 mb, about 250 mi south-southwest of Bermuda. Winds reached hurricane force the next morning, when Alice was about 150 mi south of Bermuda. The hurricane continued northward at 10 kt, with the lowest central pressure of 986 mb and maximum sustained winds of 80 kt occurring as the center passed within 10 mi of the western tip of the island, about 0600 July 4 (fig. 8). The highest sustained surface wind reported at Bermuda was 43 kt, while gusts reached 57 kt. Sustained winds reached 65 kt, with gusts to 77 kt, atop a 100-ft tower on the island. The hurricane weakened only slightly until it reached the colder waters off Nova Scotia and Newfoundland, decreasing to tropical storm strength near 43°N, 62°W, and finally merging with a frontal trough over Newfoundland on the 6th.

Mariners apparently heeded warning advisories, for no observations of gales were received until Alice moved into the more heavily traveled North Atlantic shipping lanes on the 5th. The worst marine conditions reported during Alice came from the MORMACRAY, near 36°N, 63°W, at 1800 on the 5th, when she was buffeted by 50-kt gales and 30-ft seas. No marine casualties or losses were reported during Alice.

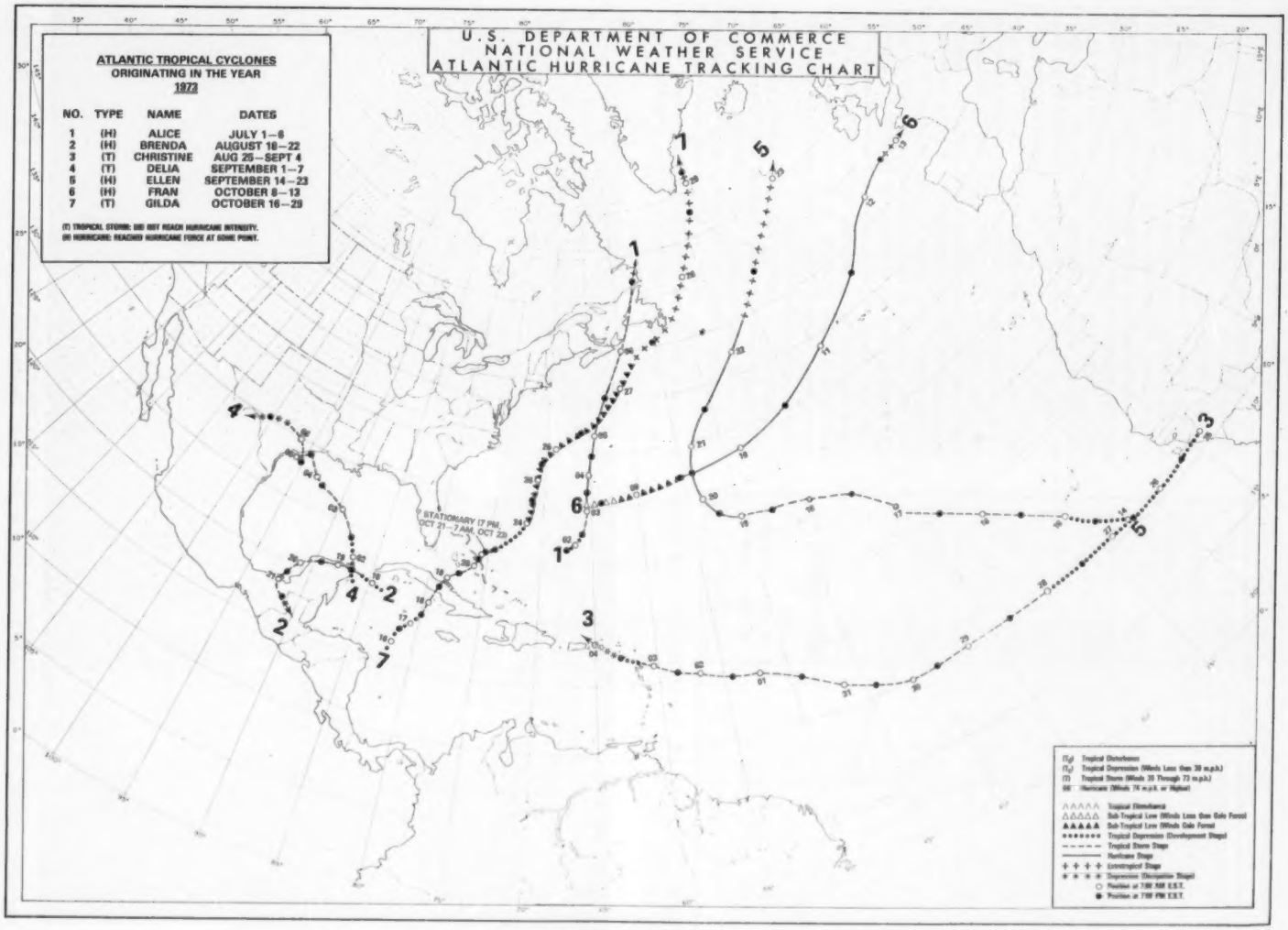

U.S. DEPARTMENT OF COMMERCE
NATIONAL WEATHER SERVICE
ATLANTIC HURRICANE TRACKING CHART
ATLANTIC TROPICAL CYCLONES
ORIGINATING IN THE YEAR
1973
NO. TYPE NAME DATES
1 (H) ALICE JULY 1—6
2 (H) BRENDA AUGUST 18—22
3 (T) CHRISTINE AUG 25—SEPT 4
4 (T) DELIA SEPTEMBER 1—7
5 (H) ELLEN SEPTEMBER 14—23
6 (H) FRAN OCTOBER 8—12
7 (T) GILDA OCTOBER 16—29
(T) TROPICAL STORM: DID NOT REACH HURRICANE INTENSITY.
(H) HURRICANE: REACHED HURRICANE FORCE AT SOME POINT.
STATIONARY (7 PM, OCT 21—7 AM, OCT 22)

Figure 6.--Tracks of North Atlantic tropical cyclones, 1973.

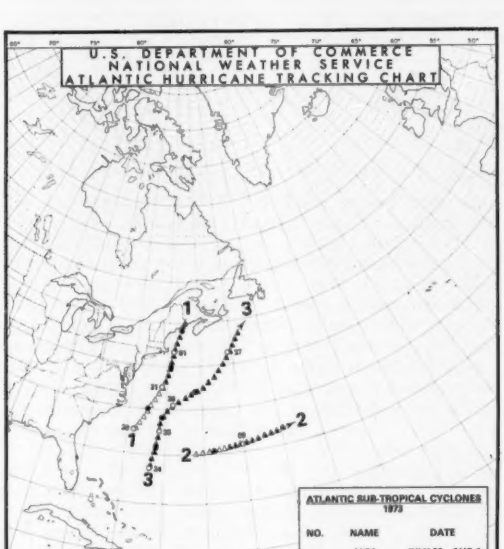


Figure 7.--Tracks of North Atlantic subtropical cyclones, 1973.

HURRICANE BRENDA, AUGUST 18-22

The disturbance which eventually developed into Brenda moved westward off the African coast south of Dakar, Senegal, on August 9. The first signs of development did not occur until a large area of showers and thunderstorms appeared on satellite pictures, as the disturbance moved into the Lesser Antilles on the 13th. This area became more concentrated as the disturbance moved through the eastern and central Caribbean, with the VOGTLAND reporting 35-kt winds near 16°N, 71°W, on the 15th. During the evening of the 17th, an unidentified ship near 21°N, 84°W reported 45-kt southeasterly winds and 18-ft seas, suggesting that not only was a LOW center finally developing, but it was fast becoming a tropical storm. The next morning, the National Hurricane Center received a ship-to-shore call from a ship believed to be the TANNY, reporting 45-kt southeasterly gales, which had shifted from the northeast at 50 to 60 kt, together with 20-ft seas. By afternoon, a reconnaissance aircraft reported winds nearing hurricane force, and the central pressure dropped to 992 mb shortly before the center moved inland, just north of Cozumel, Mexico, during the evening.

The center of Brenda moved westward across extreme northern Yucatan, passed over Merida about 24 hr after moving inland, and continued into the Bay of Campeche early on the 20th. Winds of minimum gale force were reported at Merida, and earlier at Cozumel, but were undoubtedly higher over Gulf of Mexico waters to the north. Upon reaching water,

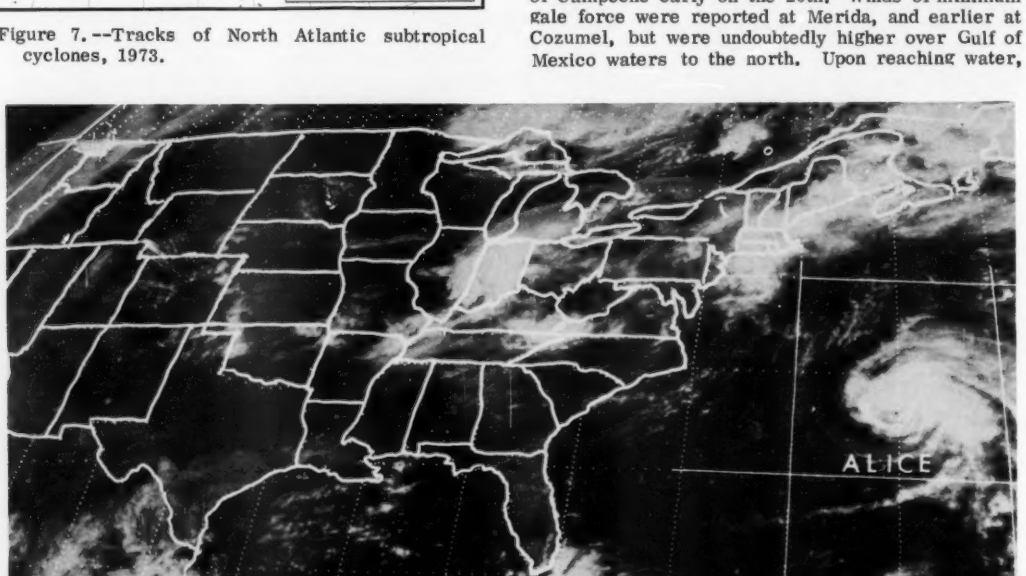


Figure 8.--While Alice didn't spoil the holiday in the United States, she brought the 4th of July to the attention of the island of Bermuda.

Table 4.--Ships encountering tropical cyclones in the North Atlantic during 1973.

Vessel	Nationality	Date	Position of Ship Lat. deg N	Position of Ship Long. deg W	Time GMT	Wind Dir.	Wind Speed kt	Pressure mb	Sea Waves* Period sec	Sea Waves* Height ft	Swell Waves Dir.*	Swell Waves Period sec	Swell Waves Height ft
ALICE		JULY											
CLAS		5	36.0	67.5	12	18	45						
WIENERTOR	GERMAN	5	35.0	56.7	12	16	35						
NORMACRAY	AMERICAN	5	36.0	62.0	18	18	50		5	20	10	5	20
NORMACRAY	AMERICAN	6	36.5	66.0	00	22	55				35	6	22
UWGQ	RUSSIAN	6	45.5	56.0	12	15	35						
UWGQ	RUSSIAN	6	45.5	56.5	18	16	40						
BRENDA		AUG											
SHIP		10	31.0	86.0	00	14	45		5	16			
MOBIL ACME	BRITISH	10	31.5	88.5	10	13	40						
KAFTAI	PAKISTAN	10	32.5	86.5	18	00	25						
MOBIL ACME	BRITISH	10	30.5	86.5	00	15	45						
MAYA	MEXICAN	10	30.5	86.5	10	20	50		5	15	05	6	15
SHIP		13	30.0	92.0	00	06	05						
CHRISTINE		AUG											
STEINFELS	GERMAN	28	33.5	53.5	21	12	35						
STEINFELS	GERMAN	29	11.0	59.5	00	17	35						
PHILDORA	LIBERIAN	31	33.5	67.5	18	10	05				10	6	15
PHILDORA	LIBERIAN	31	11.0	67.0	21	11	30		7	20	11	10	30
RHINE ORE	LIBERIAN	9/1	17.0	54.0	21	06	20		0	10	05	-	10
DELIA		SEPT											
SHIP		3	34.0	67.0	00	14	35		5	25			
VISHVA SHAKTI	INDIAN	5	36.5	65.5	00	08	25						
CORSICANA	LIBERIAN	5	36.0	66.0	06	14	45						
CARNDIE TEXAS CITY	AMERICAN	5	37.0	64.5	12	12	40						
TEXAS SUN	AMERICAN	5	36.0	60.0	12	13	45						
MOBIL POWER	AMERICAN	5	37.0	70.5	15	07	40						
MOBIL POWER	AMERICAN	6	35.0	70.5	00	15	40						
ATLANTIC HERITAGE	AMERICAN	6	37.0	61.0	10	14	35						
ZOELLA LYKES	AMERICAN	6	33.0	64.0	19	07	35	981.6					
ESSO LEXINGTON	AMERICAN	6	35.5	71.0	12	19	35						
ELLEN		SEPT											
GARONNE	FRENCH	13	14.5	25.0	15	19	40						
SHIP		20	35.0	54.5	20	13	45		20	30	15	11	15
PORT PORT CHARTRAIN	FRENCH	21	26.5	90.5	18	12	35						
ELEFLETH	GERMAN	21	35.5	13.5	18	22	35						
MORCOTO	BELGIAN	21	24.0	82.5	18	26	40		X	30	06	10	10
PORT PORT CHARTRAIN	FRENCH	21	29.0	89.0	21	13	35						
PORT PORT CHARTRAIN	FRENCH	23	29.5	86.5	12	25	50		7	15	20	11	25
LLLP		23	32.0	80.0	12	23	45		25	25	20	14	25
EXPLORER	BRITISH	23	41.0	41.0	10	11	40	985.9	5	25	25	6	7
MERCHANT	BRITISH	23	41.0	40.0	10	10	40		2	11	10	9	10
FRAN		OCT											
LLLV		10	29.5	94.5	00	25	35						
CARDIGAN BAY	BRITISH	10	32.0	51.0	00			992.0	7	12			
CARDIGAN BAY	BRIT. EM	10	32.5	49.5	12	29	03		4	13	X		25
PEUBEL OCEANIA	BELGIAN	10	31.5	44.5	12	22	05	995.0	6	20			
TAIFUN	GERMAN	10	33.0	41.0	10	09	05		5	30	03	6	12
PORT TRINITE	FRENCH	10	33.0	41.5	10	19	35		9	15			
CARDIGAN BAY	BRITISH	11	33.5	43.0	00	11	35		6	13	30	6	21
DHDU		11	35.0	44.0	00	25	30		7	20			
CARDIGAN BAY	BRITISH	11	34.5	41.5	00	29	35		6	13	35	6	21
GMPC		11	36.5	35.0	12	05	35						
HERMANN SCHULTE	GERMAN	11	29.5	24.5	12	10	40	992.0					
VARNA	BRITISH	11	28.5	24.5	12	15	40						
PORT TRINITE	FRENCH	11	24.5	25.5	12	20	35						
CARDIGAN BAY	BRITISH	11	26.5	27.5	12	29	35		6	13	30	8	25
LASH TIBURIYE	AMERICAN	11	40.9	21.0	10	10	05						
VARNA	BRITISH	11	29.0	25.0	12	20	35						
CETRA COLUMBA	FRENCH	12	47.5	14.5	12	15	35	987.5					
STAR ASHTRA	BRITISH	12	47.0	25.5	12	24	05	984.2	1	10	30	14	20
CDV "E"		12	45.0	15.5	12	22	00	982.7					
VALVATA	BRITISH	12	43.0	23.5	12	25	00		6	18			
BONNETTE	SWEDISH	13	41.0	33.5	10	32	00		12	13			
CETRA COLUMBA	FRENCH	13	44.0	13.5	10	32	05	988.0	0	13			
STEPHANTOR	GERMAN	13	46.5	18.0	10	27	00	988.0	05	25	X		05
ZAMBEZE	FRENCH	13	48.5	8.5	10	35	00	984.6					
CDV "E"		13	45.0	14.5	10	29	00						
BELVAL	BELGIAN	13	44.5	15.5	10	26	05		X	20			
GILDA		OCT											
SHIP		20	29.5	65.0	12	07	00						
M. P. GRACE	LIBERIAN	20	27.5	70.5	15	05	25						
ATLANTIC HERITAGE	LIBERIAN	20	28.0	79.5	10	00	35						
ESSO WASHINGTON	AMERICAN	20	31.5	68.0	18	02	35						
EXPORT CHALLENGER	AMERICAN	21	26.5	74.0	10	10	00						
GERO BEDTA	RUSSIAN	22	28.5	71.0	06	11	00						
OCEANIC	PANAMANIAN	23	25.0	78.0	00	01	25						
ALBERTA LYKES	AMERICAN	24	25.0	73.0	12	07	35						
H.R. MACMILLAN	BERMUDAN	24	28.5	69.0	12	16	00						
CUBA MARU	JAPANESE	24	26.0	75.5	12	14	25						

* Direction for sea waves same as wind direction.
X Direction or period of waves indeterminate.

Table 4 (cont'd).--Ships encountering tropical cyclones in the North Atlantic during 1973.

Vessel	Nationality	Date	Position of Ship Lat. deg N	Position of Ship Long. deg W	Time GMT	Wind Dir.	Wind Speed kt	Pressure mb	Sea Waves* Period sec	Sea Waves* Height ft	Swell Waves Dir.*	Swell Waves Period sec	Swell Waves Height ft
GILDA		OCT.											
SILVERSTONE	GERMAN	24	32.5	71.5	18	24	35						
ESSO HOUSTON	AMERICAN	24	30.0	68.5	18	19	45						
AMALTHEA	LIBERIAN	25	27.0	79.5	00	09	25						
EXPORT BANNER	AMERICAN	25	31.5	74.5	00	25	45						
USCGC TANEY (CHVH)	AMERICAN	25	28.0	71.0	03	07	40						
USCGC EVER-GREEN	AMERICAN	25	33.0	77.0	03	05	40						
USCGC TANEY (NVOH)	AMERICAN	25	30.0	71.0	03	07	40						
USCGC TANEY (CHVH)	AMERICAN	25	28.0	71.0	06	07	40						
USCGC TANEY (CHVH)	AMERICAN	25	30.0	71.0	12	07	50						
ARMING KNUT	AMERICAN	25	30.0	68.0	12	08	50						
HYPERION ST. LAWRENCE	BERMUDAN	25	30.0	63.0	12	14	40						
CHARLESTON	AMERICAN	25	30.0	73.5	12	04	25	986.0					
EXPORT BANNER	AMERICAN	25	30.0	76.5	12	02	45						
ORE-MERCURY	LIBERIAN	25	31.0	72.0	12	23	45						
USCGC TANEY (CHVH)	AMERICAN	25	29.0	71.0	15	07	50						
EXPORT WINNER	AMERICAN	25	30.5	76.5	15	01	45						
USCGC TANEY (NVOH)	AMERICAN	25	30.0	71.0	18	06	50						
EXPORT ARMOR	AMERICAN	25	30.0	75.0	18	01	45						
THE CAIRNS	AMERICAN	25	30.0	76.5	18	26	45						
ESSO WASHINGTON	AMERICAN	25	34.5	77.0	18	03	25						
KEN H. HOLDER	AMERICAN	25	33.5	72.5	18	25	45						
USCGC TANEY (NVOH)	AMERICAN	25	29.0	71.0	21	06	40						
EXPORT WINNER	AMERICAN	25	30.5	75.0	21	01	45						
ESSO CLEMSON	AMERICAN	25	34.5	76.0	21	24	5-						
MIXCO		25	33.5	76.5	21	25	25						
LPOI		25	31.5	77.0	21	35	35						
ANNERLIED	BRITISH	26	37.5	65.5	00	10	45						
EXPORT ARMOR	AMERICAN	26	37.0	73.0	00	26	45						
RIO ORINOCO	LIBERIAN	26	35.5	75.0	00	02	40						
ORE-ORINOCO	LIBERIAN	26	33.5	75.0	00	01	40						
TTHR		26	33.0	78.5	00	24	35						
HUNTSLEY LIGHT	AMERICAN	26	40.5	69.5	03	09	35						
USCGC TANEY (CHVH)	AMERICAN	26	30.0	70.5	03	06	35						
THE CAIRNS	AMERICAN	26	30.0	75.5	03	28	30						
TERAIC UTAH	BRITISH	26	34.0	68.5	03	28	35	992.5					
PRESIDENT LINCOLN	LIBERIAN	26	41.0	66.0	06	07	35						
HUNTSLEY LIGHT	AMERICAN	26	40.5	69.5	06	09	35						
USCGC TANEY (NVOH)	AMERICAN	26	30.0	70.5	06	06	35						
OCEANIC	PANAMANIAN	26	32.0	66.5	06	24	35						
SEA VENTURE	NORWEGIAN	26	32.0	66.5	06	29	05						
		26	30.0	67.0	09	14	35	987.0	10	12	14	10	13
HUNTSLEY LIGHT	AMERICAN	26	40.5	69.5	09	09	30						
USCGC TANEY (NVOH)	AMERICAN	26	30.0	70.5	09	07	40	984.1					
THE CAIRNS	AMERICAN	26	33.5	75.0	09	35	05						
LYKES		26	42.5	67.5	12	06	35						
USCGC TANEY (NVOH)	AMERICAN	26	30.0	71.0	12	05	30	984.5					
ADM.W.M. CALLAGHAN	AMERICAN	26	37.5	66.0	12	13	35						
PCTC		26	36.5	66.0	12	24	35						
SEA VENTURE	NORWEGIAN	26	36.5	67.5	12	12	40	985.6					
THE CAIRNS	AMERICAN	26	34.0	75.0	12	23	05						
OCEANIC	PANAMANIAN	26	34.5	65.5	12	24	35						
PRESIDENT CLAIR	AMERICAN	26	32.5	73.6	12	23	45						
ORE-MERCURY	LIBERIAN	26	30.5	75.0	12	25	05						
UPTO		26	31.0	71.0	12	27	30						
IMPERIAL ST. LAWRENCE	BERMUDAN	26	33.5	66.0	12	11	25						
		26	30.0	75.0	12	22	30		11	15	05	12	15
SHIP		26	39.5	73.0	15	01	25						
USCGC TANEY (NVOH)	AMERICAN	26	30.0	71.0	15	04	40	989.1					
ADM.W.M. CALLAGHAN	AMERICAN	26	36.5	65.0	15	12	30		7	25			
SHIP		26	32.0	68.0	15	28	60						
CAPE BRETON MINER	CANADIAN	26	42.0	60.0	18	05	35						
USCGC TANEY (CHVH)	AMERICAN	26	29.0	71.0	18	26	05	984.7	7	25	05	10	20
CHI TOKE	BRITISH	26	37.0	65.0	18	27	35						
ESSA ROVATER	BRITISH	27	48.5	58.5	00	26	25	995.3					
USCGC TANEY (NVOH)	AMERICAN	27	30.0	71.0	00	02	40						
USCGC TANEY (CHVH)	AMERICAN	27	28.0	71.0	06	26	35						
AMERICAN KILDEER	AMERICAN	27	41.0	52.5	12	10	35						
ORE-MERCURY	CANADIAN	27	44.0	67.0	12	22	05						
BLEXEN	GERMAN	27	40.0	67.0	12	15	35						
USCGC TANEY (CHVH)	AMERICAN	27	28.0	71.0	12	23	30						
SHIP		27	37.0	66.5	12	21	45						
LITA		27	35.5	69.5	12	20	25	993.0	6	13			
ATLANTIC CHAMPAGNE	FRENCH	27	35.5	67.5	18	21	40						

* Direction for sea waves same as wind direction.
X Direction or period of waves indeterminate.

Brenda intensified rapidly once again, and reached hurricane strength by early evening (fig. 9). The lowest pressure of 977 mb and maximum sustained winds of 70 kt were reported by reconnaissance air-

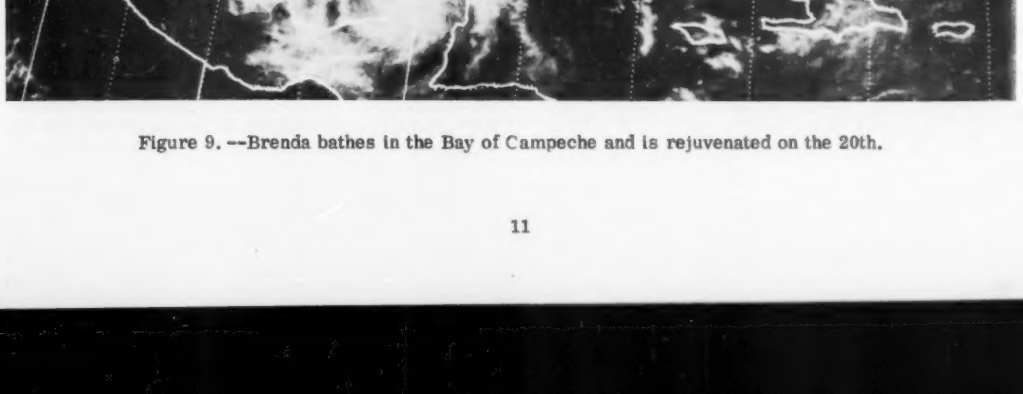


Figure 9.--Brenda bathes in the Bay of Campeche and is rejuvenated on the 20th.

craft around 0000 of the 21st, but it is likely that further strengthening occurred before landfall early the next morning. Rapid weakening occurred after landfall, and Brenda was a depression by late that day.

The turn of Brenda to the southwest and south, as high pressure built over Texas and northern Mexico, was very unusual for an August storm. Brenda was the first hurricane of record to affect the southeast coastal sections of Campeche Bay by moving onshore from the Gulf of Mexico. The only other tropical cyclones of storm intensity to move ashore in the Carmen-Campeche area occurred in October 1922 and May 1933.

One of only two ship observations of hurricane-force winds in the Atlantic in 1973 came from an unidentified ship near 20°N, 92°W, at 0000 on the 21st, when it encountered 65-kt northeasterly winds. The Greek freighter YUCATAN was crippled by Brenda, when caught by the unexpected turn to the south, but all of the 25 crewmen aboard were reported safe. In addition, Brenda terminated the almost completed Acali raft experiment, which had departed from the Canary Islands on May 12.

Carmen, Mexico, reported the highest sustained wind by a land station--45 kt--but hurricane-force winds undoubtedly occurred near and just west of the center. Ten persons were killed in coastal towns as widespread flooding occurred from Vera Cruz to Campeche.

TROPICAL STORM CHRISTINE, AUGUST 25-SEPTEMBER 4

The disturbance which developed into Christine left the West African coast as a strong depression on August 25. Satellite pictures, on the morning of the 28th, indicated the system was probably of minimal tropical storm strength. This was confirmed by the STEINFELS, which reported winds of 30 to 35 kt, veering from northeast to southeast, while passing some distance to the east of the center. Because of the marginal storm intensity and conditions believed to be unfavorable for development in advance of the LOW, the first advisory on Christine was not issued until late on the 30th. On that day, reconnaissance aircraft found a surface pressure of 1007 mb and sustained winds of 45 kt, about 1,000 mi east of Trinidad.

The storm continued west-northwestward at 10 kt, and slowly intensified until reaching maximum strength of 996 mb and 60-kt winds, early on September 2. As has been the case several times in recent years, the storm began weakening steadily as it approached the Leeward Islands, and was of less than tropical storm strength when it reached Antigua at midday on the 3d. Ship observations of sea-surface temperatures, used routinely at NHC in an automated analysis for Atlantic and Eastern Pacific waters, showed that below-normal temperatures continued to persist in the area.

A few gusts of gale force occurred westward to Puerto Rico as the depression center degenerated into an easterly wave upon approaching Puerto Rico. There was one death by electrocution from a fallen powerline in Puerto Rico. Marine interests were affected only slightly by Christine. The worst conditions reported by a ship during Christine's life was when the PHILIDORA encountered 40-kt gales and 25- to 30-ft seas, about 75 mi north of the center on the 31st.

TROPICAL STORM DELIA, SEPTEMBER 1-7

Satellite pictures showed a general increase in cloudiness over the southwestern Caribbean and Central America during the last few days of August. This seemed to be the result of an upper-level trough moving westward over Cuba combining with a disturbance moving northwestward from the Canal Zone. A weak cyclonic circulation became evident over the Gulf of Honduras on the 31st. Satellite pictures showed the depression to be better organized on September 1, as it drifted northward along the east coast of the Yucatan Peninsula. The depression moved northwestward into the Gulf of Mexico during the night, and, by the afternoon of the 2d, reconnaissance aircraft found a central pressure of 1000 mb and 45-kt winds near 23°N, 87°W. Delia turned to a more westerly course during the night and increased in forward speed while continuing to intensify. This brought the CORSICANA, which was attempting to skirt the storm to the west and south, within the radius of strongest winds at 0600 on the 3d. Southeasterly gales of 55 kt were encountered near 24°N, 88°W--very close to the center of the storm. These were the worst conditions reported by a vessel during Delia.

The storm slowed during the evening of the 3d, making a small loop, and looped again as it reached the Texas coast near Galveston, late on the 4th (fig. 10), making a second landfall in the same area 24 hr later. This erratic behavior resulted from a combination of passing anticyclones to the north and large falls in pressure south of the storm. The latter also inhibited significant strengthening. Reconnaissance aircraft measured sustained winds of 60 kt on the 3d,

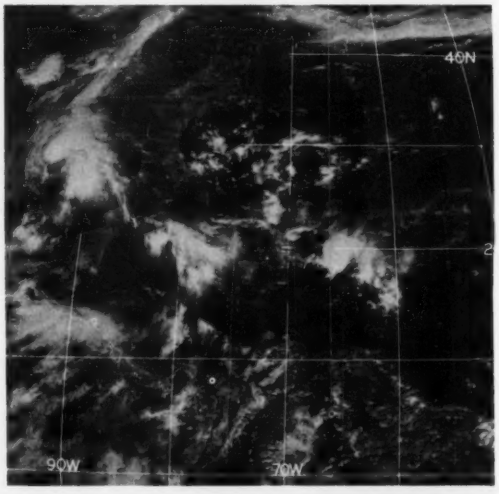


Figure 10. --Delia douses the Texas-Louisiana coast while Christine dies off Puerto Rico on the 4th.

Figure 11. --Food prices are high, but to risk your life for fish during Delia isn't the answer (September 4, High Island, Tex.). Wide World Photos.

Figure 12. --Tropical storm Delia pushes Clear Creek Channel, which flows into Galveston Bay, out of its banks on the 4th. Wide World Photos.

4th, and 5th, and squalls well above hurricane strength were reported some distance from the center on the latter 2 days. However, Delia never developed the classic wall cloud of a hurricane, and sustained winds remained just below hurricane force. The lowest pressure of 986 mb was reported by reconnaissance aircraft just prior to the first landfall on the 4th. The storm weakened to a depression over south central Texas less than 12 hr after the second landfall.

Gales of 40 to 45 kt occurred from Freeport to Galveston, with gusts of 50 to 60 kt (fig. 11). Tides of 5 to 7 ft above mean sea level in Galveston Bay caused flooding of the Baytown area and an estimated $3 million in losses for homeowners (fig. 12). Coastal marine interests apparently suffered only minor losses from Delia. Significant additional damage to crops estimated at $3 million resulted from 8-to 10-in rains over southeastern Texas and southwestern Louisiana. These losses were augmented when a strong tropical depression moved into the same area

5 days later and became nearly stationary, producing 15 in of additional rainfall along the Texas coast and raising total crop losses to an estimated $15 million. There were five deaths indirectly attributed to Delia in the Houston-Galveston area.

HURRICANE ELLEN, SEPTEMBER 14-23

Ellen was the first hurricane to affect the North Atlantic between 15° to 30°N and east of 40°W since Faith of 1966. Ellen was the most intense hurricane of the season, with NOAA reconnaissance aircraft measuring sustained winds of 120 kt at 1,500 ft and a minimum central pressure of 962 mb, near 36°N, 52°W, after the storm had recurved on the 21st (fig. 13). The paucity of gale observations in table 4 indicates marine advisories were well heeded during Ellen.

As in the case of Christine, Ellen formed from an African disturbance. The cloud system moved off the coast on September 11 and formed a depression south of the Cape Verde Islands on the 14th. Twenty-four hours later, the GARONNE passed through the system and encountered 40-kt southerly squalls near 15°N, 26°W, suggesting that a storm had formed about 75 mi off the southwesternmost Cape Verdes. Again, as in Christine, because of the marginal storm strength, sparcity of conclusive data, and unfavorable conditions in advance of the system, the first advisory on Ellen was not issued until the 17th. On that day, reconnaissance aircraft found a minimum pressure of 1005 mb and 50-kt surface winds.

Ellen had moved steadily northwestward at 17 kt since leaving the Cape Verdes. Under the influence of a strong HIGH to the north, the storm turned more westward on the 18th, and strengthened to hurricane force on the 19th, just prior to recurving. Reconnaissance aircraft found a 985-mb central pressure and 80-kt surface winds at midday.

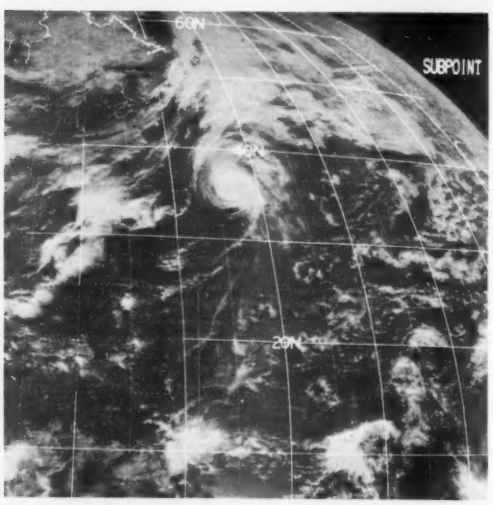


Figure 13. --The dangerous but beautiful Ellen stalks the North Atlantic on the 21st, before merging with the frontal system to the northwest.

The hurricane accelerated northeastward, ahead of a low-pressure system which was moving eastward from the United States and Canada, and reached a forward speed of 50 kt by the 22d. It merged with a frontal zone and became extratropical while passing about 650 mi east of Newfoundland at midday.

The worst conditions reported during Ellen's life were experienced by the FORT PORT CHARTRAIN and a ship with call letters LLLW, near 39°N, 45°W, at 1200 on the 22d. The former suffered from 50-kt gales and the latter, 45-kt winds, with both reporting 26-ft seas. Ellen was the only tropical cyclone of the season not to affect any land areas. No casualties or major damage to shipping has been reported.

HURRICANE FRAN, OCTOBER 8-13

A rather large area of showers located north of Hispaniola on October 1 was the weather disturbance which eventually gave birth to subtropical cyclone Bravo, which in turn matured to hurricane Fran. The shower area was associated with an upper-level trough of low pressure that had been moving westward across the Atlantic during the preceding week, and may possibly have originated in Africa. The area of showers continued westward to the western Bahamas before becoming stationary on the 4th. Reports of light westerly winds from the DISCOVERER and MALLORY LYKES, just east of Florida on the 5th, suggested a closed circulation was developing. Ship reports confirmed the continued existence and eastward drift of this weak circulation on the 6th and 7th, with the LOW near 29°N, 71°W, on the morning of the 7th. Twenty-four hours later, observations from the AMSTELPARK and GRAIGFFION clearly indicated a 1008-mb LOW near 30°N, 67°W. During the late afternoon and evening, the HAHNENTOR passed just south of the center, located near 30°N, 65°W, and reported winds of 25 kt veering from a southerly to a northwesterly direction. Reconnaissance aircraft found 35-kt surface winds some distance from the center. The system appeared to have characteristics more subtropical than tropical, and was designated Bravo that evening, while located about 125 mi south of Bermuda. By the next day (9th), reconnaissance aircraft found hurricane-force winds of 70 kt very close to the center, and a distinctly tropical system. Bravo was reclassified as hurricane Fran while located near 32°N, 55°W.

Some of the strongest winds of the hurricane season were reported by ships during the next 3 days, as Fran gradually accelerated towards the east-northeast, from a forward speed of 20 kt on the 9th, to 35 kt while passing just northwest of the Azores on the 11th. One of the two ship observations of hurricane-force winds was received from the FRUBEL OCEANIA, near 32°N, 49°W, at 1200 on the 10th; the ship was buffeted by 65-kt southwesterly winds. Twenty-four hours later, the HERMAN SCHULTE was reporting southerly 60-kt gales near 39°N, 32°W. The central pressure in Fran continued to fall, with the CETRA COLUMBA, located 30 mi east of the center, near 48°N, 13°W, at 1800 on the 12th, recording 981 mb. The STEPHANITOR, about 125 mi to the southwest, near 47°N, 16°W, registered 982-mb, westerly gales to 60-kt, and 26- to 33-ft seas. From these two ship reports,

the lowest central pressure during Fran's life was calculated to be 978 mb.

On October 11, the hurricane's center passed about 30 mi north of the islands of Flores and Corvo in the Azores. Surface winds of 35 to 45 kt were reported at 1200 and 1800, but the maximum winds actually observed there are not known. Fran finally merged with a cold front, becoming extratropical off the French coast near Brest on the 13th. Thus far, no casualties or significant damage has been attributed to Fran.

TROPICAL STORM GILDA, OCTOBER 16-29

As in several earlier storms, the development of Gilda seemed to be at least partially influenced by an African disturbance. The disturbance in question left the coast on October 3, reached the eastern Caribbean on October 10, and slowed considerably, moving only to a position south of Haiti by the 13th. Cloudiness and shower activity became more widespread over the northwestern Caribbean on the 15th, with a weak depression developing near 16°N, 82°W, by the end of the day. An unidentified ship near 11°N, 82°W, late on the 16th, reported a west-northwesterly 10-kt wind, suggesting the beginning of significant strengthening. Surface observations from Grand Cayman during the night indicated the depression was drifting northeastward and continuing to strengthen. By afternoon of the 17th, a reconnaissance flight found a central pressure of 1002 mb, which had dropped to 996 mb by 0000 on the 18th. Tropical storm Gilda had formed just 60 mi east of Grand Cayman.

The storm continued slowly northward during the next 36 hr. It then turned towards the northeast, after leaving the north coast of Cuba on the morning of the 19th. The highest sustained winds of 50 kt came from Gran Piedra, a mountain station over 100 mi east of the storm center. The lowest central pressure during Gilda's tropical life, 994 mb, together with the highest sustained wind of 50 kt, was measured by a NOAA reconnaissance aircraft late on the 19th, just off the southern tip of Andros Island. Several U. S. Navy automatic weather stations reported wind gusts in excess of 59 kt during October 19-20, with the highest value of 67 kt at Goulding Cay.

Increasing westerly winds, aloft over the storm on the 20th, gradually separated the convection from Gilda's low-level circulation. As in Christine's case, the result was a gradual weakening, until winds decreased to less than tropical storm strength on the 22d. Rising pressures around Gilda had caused the center to stall on the 21st, while located about 60 mi east of Harbour Island in the central Bahamas.

The depression remained stationary for 48 hr, until the morning of the 23d. During this time, winds of near gale force and rough seas lashed the coastal sections of most of the South Atlantic States and the western and central Bahamas. This was to appear relatively inconsequential 24 to 48 hr later, as the depression moved northeastward and then northward, and acquired the characteristics of a large, severe subtropical cyclone.

As surface pressures began to fall over the southeastern United States, the EXPORT BANNER, near 25°N, 74°W, at 0000 on the 24th, reported southwesterly 25-kt winds and a pressure of 1003 mb, indicating the low center was on the move and deepening. Six hours later, the BANNER, near 27°N, 74°W, was reporting northwesterly 20-kt winds and a 1001-mb pressure, indicating the center was moving northeastward at better than 10 kt. During the next 36 hr, the BANNER was to be buffeted almost continuously by northerly gales of 35 to 45 kt, as the ship and storm proceeded northward at about the same speed. Extropical storm Gilda, now a huge, severe storm with a central pressure of 985 mb, was located midway between Bermuda and Hatteras on the 25th and dealing marine interests plenty of grief. The circulation of the storm covered the entire southwest North Atlantic (fig. 14). As many gale observations were received during this portion of Gilda's life as from all of the North Atlantic tropical cyclones of 1973. The 50-kt gales reached out more than 200 mi from the center. The USCGC TANEY (OSV "H"), stationed near 38°N, 71°W, endured gales for 96 hr, and 50-kt winds for 24 hr. Seas rose to a peak 28 ft during the evening of the 25th and early morning hours of the 26th. Several other ships reported 50-kt gales and seas 20-ft or more on the 25th and 26th. The pounding surf produced considerable beach erosion and some property damage from New Jersey to Florida, but no dollar estimates are now available.

The severe storm turned northeastward away from the United States on the 26th, and decreased very

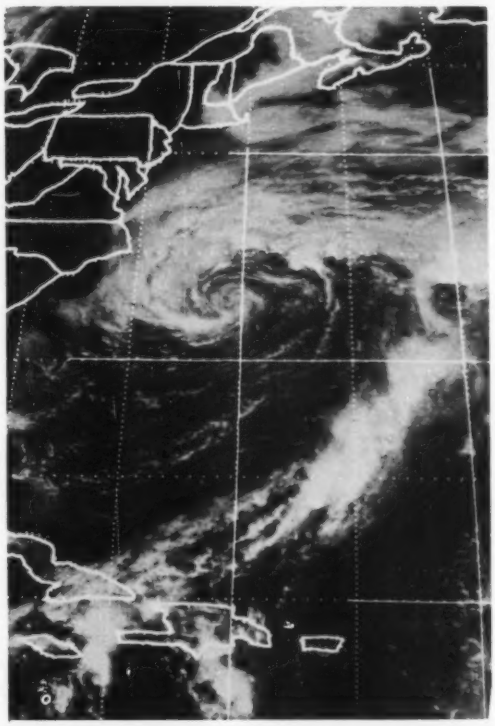


Figure 14.--The worst was yet to come, as Gilda, midway between Bermuda and Cape Hatteras on the 25th, intensifies into a severe subtropical storm.

little in strength before becoming extratropical just southeast of Sable Island, Nova Scotia, on the afternoon of the 27th. The central pressure dropped to 968 mb while passing east of Newfoundland early on the 28th.

The highest sustained ship-reported wind, during the tropical portion of Gilda's life, was 40 kt, reported by the EXPORT CHALLENGER and GEROI BRESTA, northeast of the central Bahamas, on October 21 and 22, respectively, and an unidentified ship off Daytona Beach, Fla., on the 20th. During the subtropical portion of Gilda's path, 55-kt gales were reported by the SILVERSTONE, near 33°N, 72°W, on the 24th, and a ship near 32°N, 67°W, early on the 26th. Several ships which reported seas greater than 20 ft can be found in table 4.

While such a major storm must have caused some cargo damage, no reports of marine fatalities have been received thus far. The extratropical portion of this storm became the Monster of the Month and is described in the Rough Log, on page 57 of this issue.

SUBTROPICAL CYCLONE ALFA, JULY 30-AUGUST 1

In addition to the subtropical portions of Fran and Gilda, one other small subtropical cyclone--dubbed Alfa--produced 35- to 40-kt winds on July 31 and August 1, as it moved north-northeastward about 100 to 200 mi offshore from New Jersey to New England. It weakened before making landfall in Maine, and produced no deaths or damages.

ACKNOWLEDGMENTS

Portions of the narrative on the individual storms are based on preliminary reports by other hurricane forecasters at Miami, New Orleans, Washington, Boston, and San Juan.

WE OF NOAA ARE MAKING USE OF THIS SMALL AMOUNT OF SPACE TO EXTEND OUR THANKS TO ALL THE SHIPS' OFFICERS WHO ROUTINELY TAKE SHIPBOARD WEATHER OBSERVATIONS. TO US, THESE EXCELLENT OBSERVATIONS ARE PRICELESS. WE CERTAINLY DO APPRECIATE RECEIVING THEM ON A REGULAR BASIS.

GREAT LAKES ICE NAVIGATION CENTER

Daron Boyce
Ice Navigation Center
Cleveland, Ohio

It's early January, and a huge laker loaded down with iron ore is approaching the eastern end of Lake Superior. Winds are howling from the northwest at 40 kt, waves are whipped into 10-ft-high mountains, and a heavy snow cuts the visibility to less than a few hundred feet. The trip thus far has not been easy, in the chilling cold of winter, but the ship's captain and his mates know that a big challenge awaits them ahead--ice in Whitefish Bay, the St. Mary's River, and the Straits of Mackinac.

How difficult will the journey through the ice be? Will icebreaker assistance be required? Will the northwest winds continue to drive the ice on Lake Superior into windrows to slow the ship's passage? All of these questions are racing through the crew's minds, but the answers will not be a mystery for long. The captain radios ahead to the Coast Guard Base at Sault Ste. Marie via a new high-level VHF radio system only recently activated in the region. He learns from the Daily Ice Summary that the ice conditions in the Bay have worsened considerably since his upbound trip, and icebreaker assistance probably will be needed.

Earlier in the afternoon, the captain had received a wind and temperature forecast via a telecopier installed on the bridge. Since the ice is going to be tough, he decides to get the latest imagery of the area. He radios marine radio station WAS, Duluth, through a remote site at Copper Harbor, and asks for the Eastern Superior ice chart. About 10 min later, he has a radar "picture" and an analysis of the ice in his hand. The chart confirms the problem areas ahead, and plans are formulated for a rendezvous with two other ships for a convoy eastward through the ice field.

Scenes like this will be common this year on the Great Lakes. The Great Lakes-St. Lawrence Seaway Navigation Season Extension Program is in its third year, and every available technique to provide the shipper on the lakes with the best possible information on weather and ice conditions is being made. (See Mariners Weather Log, May 1973.) The heart of the information program is the Ice Navigation Center, located in the Ninth Coast Guard District Headquarters in Cleveland, Ohio. It is the job of the staff at the Center to collect information from dozens of sources, to analyze it, and to disseminate it back to a variety of users, including shipping companies, ships underway, and numerous government agencies all working together to make the demonstration program a success.

The Ice Navigation Center was established in January 1971 by the U.S. Coast Guard to collect and provide ice data in connection with icebreaker support to the Great Lakes merchant fleet. Traditionally, before the Winter Navigation Demonstration Program, shipping laid up for the winter by mid-December. Under the program, which was established by Congress under the direction of the U.S. Army Corps of Engineers, shipping continued to February 1, 1972, and to February 8, 1973.

During the Center's first full season of operation, it was manned solely by Coast Guard personnel from the Ninth Headquarters Operations Division. For the 1972-73 season, a National Weather Service Forecaster was added to the staff. This unique blending of personnel from the two agencies at one location was a first. This year (1973-74) the Center will be staffed by Chief Quartermaster Robert Swain, Petty Officer James Burrell, and Petty Officer Daniel Hislop from the Coast Guard, and Daron Boyce, National Weather Service, Great Lakes Ice Forecaster. The center operates under the direction of Lt. Thomas Brennan, Chief of the Ninth Coast Guard Icebreaking Section.

ICE DATA COLLECTION

Data on ice conditions come from many sources (fig. 15) around the lakes. Observations are taken by land, sea, and air, and forwarded to the Center by teletype, telephone, or facsimile.

The U.S. Coast Guard provides most of the in-situ ice information through their network of shore stations, scattered around the lakes for search and rescue work and maintenance of navigational aids. Forty-eight units make daily observations of ice type, coverage, and thickness. These observations, teletyped into the Ice Center three times a week, provide most of the thickness information, included in the Daily Ice Summary and on the charts issued from the Center.

The coverage of ice on the open lake, as well as near shore, cannot be observed adequately from the shore, so aerial reconnaissance flights are a key part of the Coast Guard data acquisition plan.

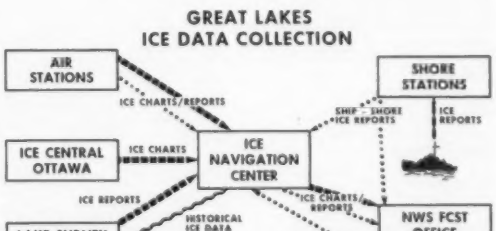


Figure 15.--Ice data flows into the Ice Navigation Center at the Ninth Coast Guard Headquarters in Cleveland from a variety of locations and sources.

Figure 16.--The U.S. Coast Guard's HH52A helicopter does the bulk of the visual ice reconnaissance work on Lake Huron and Lake Erie and connecting channels. U.S. Coast Guard Photo.

Figure 17.--The Coast Guard HU16E aircraft, based at Traverse City, Mich., makes frequent ice reconnaissance flights over the upper lakes. This flight was over the Straits of Mackinac late last winter. U.S. Coast Guard Photo.

HH52A helicopters (fig. 16), based at Traverse City, Mich., Detroit, Mich., and Chicago, Ill., make routine flights over the lakes and connecting channels. Coast Guard or NOAA-Lake Survey Center ice observers plot coverage maps of the ice conditions and send them by facsimile back to the Ice Center soon after touchdown. HU16E fixed-wing aircraft (fig. 17) at Traverse City make almost daily flights between Sault Ste. Marie and Duluth over Lake Superior.

During the current ice season, an additional ice observation system has been introduced on the lakes--Side-Looking Airborne Radar (SLAR). Through the cooperation of NASA in Cleveland and the U. S. Army, and as part of the Ice Information Working Group activities, regularly scheduled SLAR flights have been made over most of the lakes system. Two radar units, one on each side, are being used on board each of three OV-1 aircraft. Each radar has a range of 30 mi, for a total swarth of about 60 mi. The reflected radar signal is recorded on photographic film. Following the flight, the film is processed and a radar image of the ice cover much like a snapshot of the lake is available for more detailed study and analysis. A distinct advantage of this system is its ability to operate during periods of weather without visual ground contact. These images are being sent from Kincheloe Air Force Base, in upper Michigan, to the Ice Navigation Center by high-resolution telecopier.

Ships underway in the ice fields (fig. 18) also provide valuable data on ice coverage, estimated thickness, and, perhaps most importantly, navigational problems encountered. Much of these data is exchanged directly between ships, but the Coast Guard shore units also collect these ice messages for relay to the Ice Center. Coast Guard icebreakers contribute a great deal of information on problem areas. In many cases, when conditions become severe, they make recommendations on the size ship and minimum horsepower required to transit heavy ice fields.

Data are collected from a number of other sources as they become available. These include all the ice information obtained by our Canadian counterparts in Ice Central at Ottawa, Quebec. Ice information for the St. Lawrence Seaway is available from the Seaway Development Corp., in the United States, and the Canadian Seaway Authority. Water temperatures and a

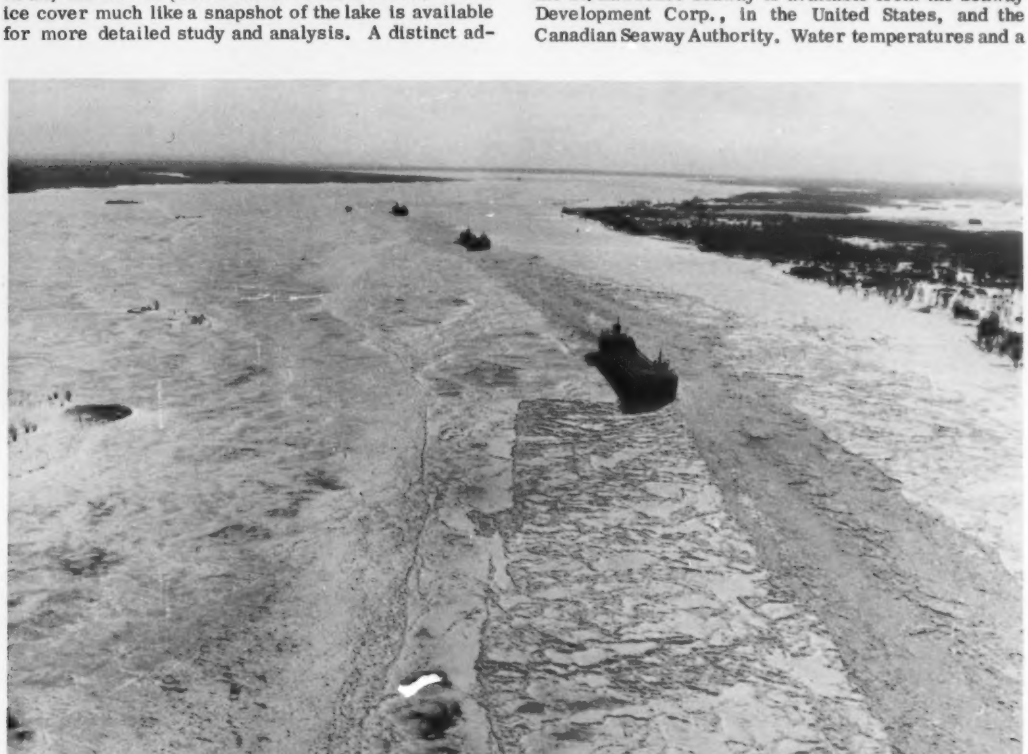


Figure 18.--During the winter months when ice conditions become severe, ships frequently convoy together through the ice fields. These vessels provide valuable ice data while in transit. U. S. Steel Photo.

Figure 19.--Petty Officer James Burrell, a First Class Radarman in the Coast Guard, puts the finishing touches on a composite ice chart. The large ice charts are frequently used for briefings and presentations for the Ninth Coast Guard Operations Division and the Lakes Carriers Association Ice Committee. U.S. Coast Guard Photo.

wide range of historical data are also supplied by the Ice and Snow Section of the Lake Survey Center in Detroit. Lake Survey is the official repository for all Great Lakes ice data.

Considerable weather information also flows into the Ice Center from around the Great Lakes and the Nation. The Center is equipped with the two standard National Weather Service teletype circuits and a receiver on the weather map facsimile circuit from the National Meteorological Center near Washington, D. C. Observations and forecasts from most of the nation are received routinely. A special marine weather data teletype circuit ties the Ice Center to United States and Canadian Forecast Offices, major users, and marine radio stations. Weather observations from the network of Coast Guard shore units and from about 100 United States and Canadian ships are received several times daily.

Another integral part of the input to the Ice Center comes from the National Weather Service Forecast Office in Detroit, Mich. The Detroit office is charged with making all the ice forecasts for the lakes. A team of meteorologists under contract to NWS assists in the preparation of a number of daily products, as well as less frequent long-range outlooks.

ANALYSIS AND DISSEMINATION

After receipt of the data, the real work begins for the Ice Center team. Shore observations are combined with the aerial observations, and the combination is in turn meshed with similar data from Canada. Two main products are generated--ice charts (fig. 19) and a verbal summary.

During the past seasons, a daily composite ice analysis of the whole lake system was the main graphic presentation emanating from the Center. This year, with the addition of SLAR imagery, more detailed charts of smaller areas are being prepared.

Ice and weather data, in both graphic and tele-

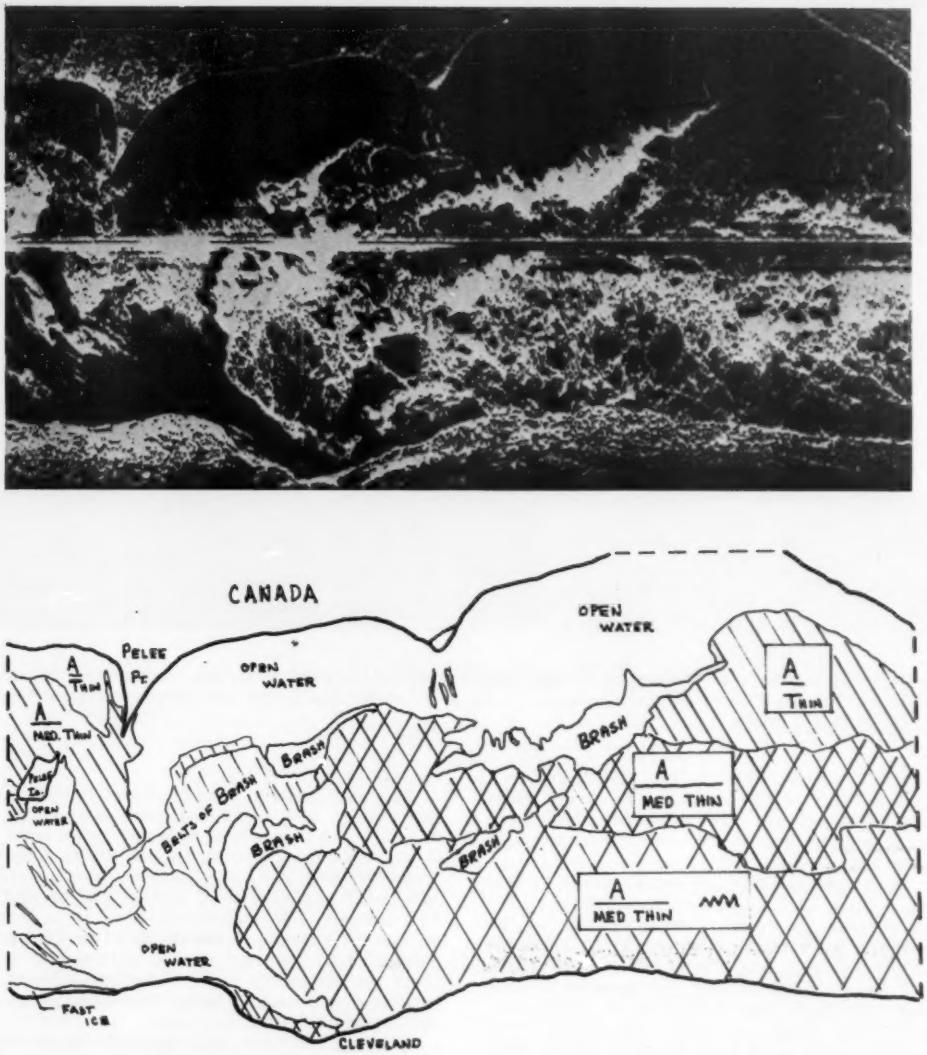


Figure 20.--Side-Looking Airborne Radar (SLAR) is being used to observe the Great Lakes ice cover this winter. This composite is typical of the charts ships on the Great Lakes are receiving by radiofax. The top section is the SLAR image of the ice on Lake Erie in February 1973. The bottom section shows the graphic analysis made from the SLAR image. SLAR flights are made almost daily by the U. S. Army and NASA in a joint project, as part of the Extension Season Demonstration Program on the Great Lakes.

graphic form, are transmitted to shipping companies, other Federal agencies in the demonstration program, and, most importantly, the vessels underway.

The new VHF communications system on the Great Lakes, being developed by Lorain Electronics of Lorain, Ohio, the Maritime Administration, and Lake Carriers Association, has added a whole new facet to the communications program. For the first time, a facsimile transmission from a land station to a ship is possible on the lakes. When the full automated network is completed, the possibilities of this new hardcopy transmission seem unlimited. Under the prototype plan this winter, only a few basic weather and ice coverage charts are being sent manually to ships with telecopier equipment.

After new information for a given area of the lakes is received and analyzed, a composite chart (fig. 20) of the original SLAR image and the line drawing are

Figure 21.--National Weather Service Ice Forecaster Daron Boyce updates the current weather picture in daily briefings. The Ice Center is staffed jointly by the U.S. Coast Guard and the National Weather Service. U.S. Coast Guard Photo.

transmitted to Lorain, Ohio, Duluth, Minn., and Port Washington, Wis. Each commercial marine radio station stores the chart on a tape recording for replay to ships on request, as they move through the station's broadcast area.

The same three stations, as well as a fourth outlet in Rogers City, Mich., are also broadcasting a wind and temperature forecast chart prepared by the National Weather Service. The broadcasts are made twice each day and cover most of Lake Superior, northern Lake Michigan, Lake Huron, most of Lake Erie, the connecting rivers, and Lake St. Clair.

Three basic teletype products are disseminated from the Ice Center each day. They include the Daily Ice Summary, a verbal outline of existing ice conditions throughout the Lakes; an Ice Forecast, which outlines the expected ice and weather conditions for about 24 hr ahead; and an Ice Outlook, which describes the expected conditions for a 5-day period ahead. The Ice Summary is also mailed to about 50 shipping agents.

Special forecasts and charts are prepared twice each month by the National Weather Service, indicating weather and ice conditions for 30 days in advance. Charts of the normal ice cover for the period are subjectively modified using the 30-day average temperature outlook and existing ice conditions. These ice outlooks are presented in chart form and are mailed along with the Ice Summary to the shipping companies.

Personal contact directly with shipping agents, ship crews, and operations personnel of the Coast Guard is also a very important part of the team effort of the Ice Center staff. An operations briefing is conducted each day at the Ninth District Coast Guard Headquarters. A detailed look at existing and forecast ice and weather conditions (fig. 21) is presented to Admiral Heckman, Commander of the District, and his staff. Icebreaking forces stationed in various ports are frequently deployed on the basis of these briefings, resulting in better service to shipping and and saving of government funds.

Meetings are also held regularly during the ice season with the Lake Carriers Association Ice Committee. Ice and weather briefings are an integral part of these sessions. In turn, the shippers brief the Coast Guard and other interested agencies on their sailing schedules.

Both the National Weather Service Forecaster and the Coast Guard Ice Center staff are available to assist individual ship captains or vessel agents on request. They are encouraged to check out any questionable conditions affecting their voyages by calling the Center for assistance. The staff is available from 7:30 a.m. to 4:00 p.m., Monday through Friday, and on weekends during the critical parts of the ice season.

Hints to the Observer

SHIP REPORTS NEAR COASTS

Many storms have their origin or greatly intensify just off the coasts of land masses. Weather reports from ships near coasts are important, and sometimes more important than reports of the weather farther at sea. It is vital to know of the existence and character of storms along the coasts, for forecasting how and when they might affect land areas, especially built-up coastal areas, including ports and coastal shipping.

Weather forecasting is extremely dependent on knowing the current weather. In general, the forecasts can be no better than the weather observations. Ship reports are one of our most important sources of information for vast areas where there are no other reliable and accurate sources for measuring the surface weather conditions.

Meteorological satellites are providing important information, with detail and data continually improving, but they cannot replace good measurements of pressure and pressure changes, air and sea temperatures, sea conditions, and pertinent remarks provided by ship reports. Buoys are being tested and appear to have great potential, but it will probably be many years before their coverage can compare with the number of ship reports available.

The placement of buoys is a good example of the importance of near shore observations, as the first are being moored near-shore, where storms historically form or intensify.

We urgently need your ship observations. To help us do a better job, we ask that weather reports be made and transmitted whenever possible without regard to proximity to land.

Tips to the Radio Officer

Warren D. Hight
National Weather Service, NOAA
Silver Spring, Md.

CHANGES IN PUBLICATION U. S. AND FOREIGN COASTAL RADIO STATIONS ACCEPTING SHIPS' WEATHER OBSERVATION MESSAGES (1973 Ed.)

Page 8--Station NMO, Honolulu, Hawaii: Revise list of frequencies to read 440, 8650, 12889.5, 17247.2 (day).

Page 8--Station NMJ, Ketchikan, Alaska: Delete 8728 kHz.

Page 8--Under Canada, add: 4YP Ocean Weather Station 480 50-00N 145-00W

Page 9--Under United Kingdom, amend GKH, Portishead frequencies as follows (suggest data be entered at bottom of page):
GKB2 4274; GKB3 6379.5; GKB4 8557.9; GKB5 12835.5; GKB6 17113; GKB7 22448.7; GKC2 4251.5; GKC3 6407.5; GKC4 8516; GKC5 13020; GKC6 16954.4; GKC7 22407.3; GKD2 4256; GKD3 6428.5; GKD4 8569.5; GKD5 12788.5; GKD6 16974.6; GKD7 22431
Note: GKC and GKD series are used at busy periods only. The 8 mHz band is open continuously; others are subject to seasonal changes. Automatic tape "DE GKB" indicates frequencies open for traffic.

Page 14-Chosi (JCT, JCU): James E. Eikenberg, Radio Officer, SS PRESIDENT MONROE, offers the information that OBS messages are given priority during the first 30 min after the synoptic (OBS) hour as follows: JCT, on 4 and 17 mHz; JCU, on 8 and 12 mHz.

Page 14-Okinawa (JCX): Enter name "Naha" preceding "Okinawa." Add frequency 13086 kHz.

Page 14-Nagasaki (JOS): OBS messages are given priority during the first 20 min after the synoptic (OBS) hour on the 6, 8, 13, and 16 mHz bands.

Page 14-Hong Kong (GZO): Delete details (this station accepts observation messages from British Commonwealth ships only).

Page 14-In lieu of GZO, enter the following:
VPS Hong Kong 527.5 6371 8539 22-13N 13020 "OBS MET HONG KONG" 114-15E 17096 22536

Page 14-Add the following stations:
XSX Keelung, Taiwan 420 8714 ____ 12695 "METEO TAIPEI" ____
XSW Kaohsiung, Taiwan 460 8582 ____ "METEO TAIPEI" ____

Pages 14 and 15--Radio Station NRV, Guam: According to AMVER Bulletin, the only frequency used is 466 kHz. Delete all others.

NEW PUBLICATION WORLDWIDE MARINE WEATHER BROADCASTS

Good news! (Keep your fingers crossed.) Ships in the United States weather reporting program will be mailed copies of the new publication, Worldwide Marine Weather Broadcasts, in February. With the issuance of this publication, H. O. Pub. 118 will be discontinued. Corrections will be published in the weekly Notice to Mariners, as well as in the Mariners Weather Log.

Plans are being developed to ensure issuance of yearly editions.

CHANGES IN MARINE RADIO BROADCASTS

Some of the information contained in Worldwide Marine Weather Broadcasts, soon to be published, will be obsolete by the time the booklet is in your hands. Although necessary corrections will be issued soon after publication, we think the following changes are important enough to publish here. It would be advisable to keep this information handy in your copy of Weather Service for Merchant Shipping and transfer it to Worldwide Marine Weather Broadcasts when you receive it.

RADIOTELEGRAPH BROADCAST

Station: Lantana (Miami), Fla. (WOE)

Change broadcast times to 0105 and 1305.

RADIOFACSIMILE TRANSMISSIONS

Station: Brentwood, Long Island, N.Y. (WFH, WFK)

Add the following transmissions, which will commence about January 1, 1974:

1039 and 2302 - 24-hr surface prognosis
24-hr sea and wind prognosis
(heights in meters)

Note: These charts will cover the Atlantic area 10°S-45°N, from 10°W to 100°W.

Station: San Francisco, Calif. (NMC)(U.S.Coast Guard)
Service area: Eastern and Central Pacific Ocean
Frequencies (kHz): 4344.1, 8680.1, 12728.1, and 17149.3 at 1820, 2000, 2300 in lieu of 4344.1
Transmission speed: 120 scans/minute
Index of cooperation: 576
Map areas, projection, and scale:

A: 20°S-30°N, east of 160°W (Mercator projection scale 1:20,000,000)

B: North of 30°N, east of 160°E (Polar stereographic projection scale 1:20,000,000)

C: North Atlantic and North Pacific

Time transmission	Map area	Reference time	Content
0000	-	-	Schedule (Mondays only)
0100	B	1200	36-hr surface prognosis*
	B	1200	36-hr sea & swell prognosis*
	B	1800	Surface analysis*
	A	1800	Mean wind & weather prognosis*
	A	1800	Mean sea & swell prognosis*
0520	C	1200	Extended outlook, 72 & 96 hr
	B	0000	Surface analysis
	B	0000	Significant weather prognosis
0700	C	1200	Extended outlook, 72 & 96 hr
	B	0000	Surface analysis*
	B	0000	Significant weather prognosis*
1500	A	0600	Wind, weather, & sea condition
1820	B	1200	Surface analysis
	B	1200	Significant weather prognosis
	A	1200	Wind, weather, & sea condition
2000	B	1200	Surface analysis*
	B	1200	Significant weather prognosis*
	A	1200	Wind, weather, & sea condition*
	B	1200	36-hr surface prognosis*
	B	1200	36-hr sea & swell prognosis
2300	B	1200	36-hr surface prognosis*
	B	1200	36-hr sea & swell prognosis*
	B	1800	Surface analysis
	A	1800	Mean wind & weather prognosis
	A	1800	Mean sea & swell prognosis

*Repeated transmission

ACKNOWLEDGMENT OF COMMENTS BY 6 RADIO OFFICERS

The National Weather Service appreciates information submitted by the following radio officers:

Trevor Constable, HAWAIIAN ENTERPRISE
Charles P. Krause, no ship
Alan Marsden, ATLANTIC CONVEYOR
Fred Becker, NEW YORK GETTY
Paul Wolf, MONTPELIER VICTORY
James Eickenberg, PRESIDENT MONROE

THE MARINERS WEATHER LOG WELCOMES ARTICLES AND LETTERS FROM MARINERS RELATING TO METEOROLOGY AND OCEANOGRAPHY, INCLUDING THEIR EFFECTS ON SHIP OPERATIONS.

Hurricane Alley

Richard M. DeAngelis
Environmental Data Service, NOAA
Washington, D.C.

Few tropical cyclones develop over the North and South Indian Oceans or in the South Pacific during August and September. Activity usually increases in October. This year, a weak August depression flared briefly in the South Indian Ocean. In September, these seas spawned another tropical depression and a tropical storm (fig. 22). The other areas remained quiet. However, there were some rumblings during October; a tropical depression formed in both the North Indian and South Pacific Seas, while a tropical storm threatened shipping in the South Indian Ocean.

SOUTH INDIAN OCEAN

Early on September 11, the BRITISH MAPLE ran into 25-kt winds near 12°S, 93°E. A few hours later, the KOU ANG SI and the MAJV encountered 30-kt winds in the same general area. Their wind directions indicated a circulation was forming. This was soon verified by a satellite pass, which located a tropical depression near 7.2°S, 84.5°E, at 0210 on the 12th. The depression first headed south, then swung west-northwestward on the 13th. By this time, she was a tropical storm. On the 15th, she turned westward and the following day passed close to Diego Garcia, where a 20-kt wind was reported at 1200 on the 16th. Maximum winds were estimated at 35 kt near the storm's center (fig. 23). On the 17th, she turned southwestward and began to dissipate. By the 19th, all that was left was a weak, ill-defined cloud mass near 10°S, 60°E.

Tropical storm Bernadette was discovered as a depression on October 16. Satellite photographs placed her near 5°S, 77°E. For several days, the slowly developing system meandered southward. On the 20th, she turned toward the west near Diego Garcia. Bernadette finally reached tropical storm strength late on the 23d. She peaked on the 25th (fig. 24), when maximum winds near her center reached 60 kt--just below hurricane force. The storm remained strong through the 26th as she headed for the Mozambique Channel. However, she weakened rapidly on the 27th, and by the following day was a depression drifting across the Channel.

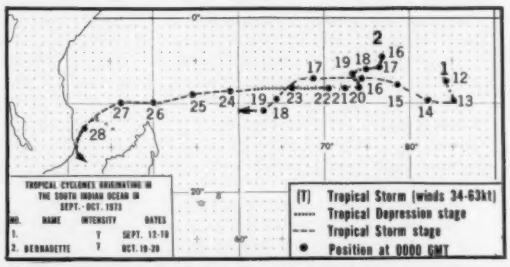

TROPICAL CYCLONES ORIGINATING IN THE SOUTH INDIAN OCEAN IN SEPT.-OCT. 1973
NO. NAME INTENSITY DATES
1. T SEPT. 12-18
2. BERNADETTE T OCT. 16-28
(T) Tropical Storm (winds 34-63kt)
Tropical Depression stage
Tropical Storm stage
Position at 0000 GMT

Figure 22.--Tracks of Indian Ocean tropical cyclones, September and October 1973.

Figure 23.--This South Indian tropical storm wasn't much to look at even when fully developed on the 16th.

JANUARY-FEBRUARY OUTLOOK

This is the most active time for tropical cyclones in the southern oceans. An average of two or three tropical storms and one hurricane occur each month in both the South Indian and South Pacific Oceans. In the South Indian Ocean, these storms are most often encountered west of 70°E, between 10° and 30°S, particularly in the seas just east of the Malagasy Republic and in the Mozambique Channel. Around Australia, midsummer activity is centered off the Queensland coast in the Coral Sea and just off the northwest coast of Western Australia.

Figure 24.--A peek at Bernadette while she peaks off the Malagasy Republic on the 25th.

On the Editor's Desk

CURRENTS CARRY DESTRUCTION TO OCEAN FLOOR

The movement of beach sand to the bottom of the ocean has been outlined in an award-winning paper by a University of Rhode Island geologist. Monty A. Hampton's study of oceanic turbidity flows was recently judged "paper of the year" by the Society of Economic Paleontologists and Mineralogists. Sand and similar shore material are carried away from the beach or river bed by normal current flow. It builds up at the edge of an underwater canyon or a river delta, until the size of the deposit or some underwater disturbance such as an earthquake causes an underwater landslide.

The slide begins as a debris flow and follows a pattern similar to the mud slides common in the canyon areas in the western United States. These mud slides have power comparable to that of a landslide. One was seen in California that came down a canyon, went through the open door of a garage, and moved the cars around inside. In the ocean, the debris flows are reported to carry boulders several feet in diameter.

As the debris flow descends a suboceanic canyon or delta edge, the top of its lead portion or snout is worn away by ocean friction, forming a muddy cloud surrounding the moving debris. Eventually the major portion of the moving mass becomes dilute enough to change from a debris flow to a turbidity current. Turbidity currents, unlike surface shore currents, respond to the pull of gravity, which gives them considerable speed. They have been measured traveling as fast as 50 kt. At such speeds, turbidity and debris flows may be responsible for the destruction of manmade structures on the ocean floor, such as transoceanic telephone cables.

To study the shape, speed, and contents of the currents, a 3- by 20- by 3-ft glass tank was built, with a movable ramp to simulate underwater slopes and hills. Using slow motion photography, it was possible to photograph the mini debris flows and turbidity currents that were created. These observations were then translated into mathematical formulas and computer programs that can now be used to predict the movements of full-sized flows.

Previous to this research, little attention was paid to the strength of these submarine mudflows or to their role in underseas destruction. The paper stresses that debris flow is also an important transport process and is opening a whole new area of research. Although any answer is far in the future, work is now being done on means of controlling these flows or preventing them.

DEEP SEA ENVIRONMENTAL BUOY BEING ANCHORED OFF SOUTHEAST COAST; TO BROADCAST VITAL WEATHER INFORMATION

The fifth in a series of large experimental data buoys (fig. 25) was deployed about 300 mi east of Charleston, S. C., and 150 mi south-southeast of Cape Hatteras, N.C. The site is somewhat east of the Gulf Stream.

The buoy is being anchored in 2,100 fathoms of water (almost 2 1/2 mi deep), where it was towed from Gulfport, Miss., by the USCGC ACUSHNET.

Figure 25.--NOAA's 100-ton experimental ocean buoy.

Designated EB-13, the 100-ton, 40-ft, discus-shaped buoy will furnish vital meteorological and oceanographic information from an area which frequently generates "Hatteras" lows and severe weather affecting the eastern United States. Engineering and environmental data will be transmitted routinely every 3 hr by EB-13 to its shore collection station at Miami, Fla., thence to the National Weather Service at Suitland, Md., and the NOAA Data Buoy Office at the Mississippi Test Facility near Bay St. Louis. High-frequency communication services are being provided by the Coast Guard, which will also furnish necessary ship servicing support for the buoy at sea.

Like its sister buoys, EB-10 and EB-12 in the Gulf of Mexico, and EB-03 in the Gulf of Alaska, EB-13 is designed to withstand 150-kt hurricane winds, 60-ft waves, 10-kt currents, and 1 yr on station without servicing. Another of its sister buoys, EB-01, is anchored in the Atlantic 125 mi southeast of Norfolk, Va.

Together, EB-13 and EB-01 will provide environmental data needed by the National Weather Service for winter storm and hurricane forecasts and warnings, as well as for daily forecast operations. The sensors will measure oceanic and atmospheric data, including wind speed and direction, rainfall, air temperature and pressure, dew point, surface water temperature and conductivity, as well as wave height and period.

The sensors are installed on the buoy's mast and on the hull. The devices are powered by a diesel generator-battery system. They are activated automatically or on signal from shore via a small computer aboard the buoy. The computer can instantly retrieve specific information from the sensing devices.

Buoys will help fill a long-recognized environmental

data gap in marine areas of the globe. More information is needed on environmental conditions over vast areas than now can be provided by satellites, occasional ships, and aircraft. Automatic buoys stationed in the oceans, coastal waters, estuaries, and large lakes provide one way of bridging this information gap. The data are required for predicting weather, sea conditions, fish migration, and other conditions which affect man and his endeavors.

NEW SATELLITE TO CONTINUE WATCH ON EARTH'S WEATHER

The NOAA-3 environmental satellite was successfully launched by NASA, from its Western Test Range, at 12:02 p.m., Eastern Standard Time, November 6. Preliminary orbital information indicates the apogee is 938 mi, the perigee, 942 mi, and the period 116.2 min. Equator crossing is approximately 8:30 a.m. local sun time southbound.

The spacecraft will be turned over to the National Environmental Satellite Service for operational use, after NASA has completed its systems checks.

Radiometers on board the spacecraft will provide visible and infrared images of cloud cover, snow, and ice, and the sea surface, and gather information on temperatures and moisture in the atmosphere. Another sensor will provide data on the solar proton count and distribution in polar regions.

The new spacecraft will be the first to transmit local-area atmosphere radiance data--from which temperature soundings can be calculated--directly to properly equipped ground stations. Several foreign countries, including Norway and France, are planning to receive and process these atmospheric soundings for operational use in weather forecasting.

The NOAA-3 will maintain the operational satellite system that for more than 7 1/2 yr has provided regular global observations of cloud systems and other environmental features for the forecasts and warning services of the United States and other nations.

Images of global weather, and soundings of atmospheric temperature and moisture, are used to improve the accuracy of large-scale weather forecasts prepared by the National Weather Service's National Meteorological Center at Suitland, Md. Data transmitted directly from the spacecraft to weather stations throughout the world have provided unprecedented observational coverage to other nations.

Since the beginning of the operational satellite system, probably no tropical cyclone at sea has gone undetected. Data from the operational system have led to improved severe local storm warnings, better predictions for the U. S. west coast, where weather systems approach from the sea, and more accurate forecasts for aviation and ocean shipping. The satellites' images also provide vital information on ice in the Great Lakes and in polar regions, sea-surface temperatures, and snow cover in mountainous areas.

Another of the diverse uses of satellite information is in locust control. In Asmara, Ethiopia, the agency responsible for controlling these destructive insects in eastern Africa uses satellite pictures to watch for weather conditions that favor breeding and swarming.

HAWAIIAN ISLAND BECOMES PLATFORM FOR TSUNAMI SCIENTISTS

Researchers with the Environmental Research Laboratories are using a new instrument--Hawaii's island of Oahu, slightly modified--to obtain unique measurements of large-scale water motions in the central North Pacific Ocean area.

The modification consists of three pairs of electrodes planted in holes 105 ft deep, drilled down to the saltwater table (which underlies the island's freshwater table) on the grounds of NOAA's Honolulu Observatory site at Ewa Beach. These buried sensors sense the electromagnetic fields produced by electrically conducting seawater moving in the earth's magnetic field, and scientists can translate these sensations into measurements of such large, relatively slow motions as tides, planetary waves, some types of turbulence, and tsunamis--the earthquake-generated wave series popularly called "tidal waves."

The instrument system is tuned to wave motions of most interest to tsunami researchers, and tunes out smaller scale wave activity such as surf and internal waves and the effects of the island itself.

A temporary magnetotelluric electrode setup was made in the water just off Bermuda earlier this year, to provide large-scale water motion data for the area covered by MODE, the Mid-Ocean Dynamics Experiment of the International Decade of Ocean Exploration. This site was operated to contribute data to the MODE activities south of Bermuda and also to obtain magnetotelluric measurements simultaneously with conventional measurements being taken by MODE investigators.

Present plans are for the Joint Tsunami Research Effort to install two paired-electrode systems each on Coconut Island, across Oahu in Kaneohe Bay; one on Kwajalein, some 2,500 mi to the west and south; and a third on Canton Island, about 1,500 mi southwest of Hawaii.

NOAA WARNS OF FLOOD AND EROSION DANGER AROUND GREAT LAKES

High water levels in most of the Great Lakes pose a threat of flooding and shore erosion as the region enters the peak of the winter storm season.

Flood danger is greatest in low-lying areas bordering Lake Erie, the Detroit River, Lake St. Clair, and Lake Huron's Saginaw Bay. Shores along the rest of Lake Huron, Lake Michigan, and Lake Superior could be seriously eroded.

The Lake Survey Center of NOAA's National Ocean Survey reports that the water level in all of the lakes except Ontario was well above the long-term average for November, although slightly lower than last year's record highs. Accelerated release of water from Lake Ontario through the St. Lawrence River has lowered its level to a point only 3 in above the long-term November average.

The high water levels are not dangerous in themselves; it is the added ingredient of winter storms that brings the threat of flooding and erosion. Between September and April, winter storms approach the Great Lakes region from the central part of the country, with the greatest number occurring during November, December, and January. If the storm winds blow along the axis of a lake, the water is driven by the wind to the end of the lake. Piled-up waters flood into low-lying areas, and the wind-whipped waves beat at the shorelines, causing serious property losses. Just a year ago, on November 14, 1972,

Figure 26.--Storm takes cottage--a cottage collapsed under the pounding of waves in the Lake Erie storm of November 1972. The effects of the storm were heightened by the high water levels on the Lake. Wide World Photo.

strong winds piled up Lake Erie's water at its western end, and the ensuing flood caused $22 million damage (fig. 26).

Great Lakes-area offices of NOAA's National Weather Service receive a continuous flow of lake-level observations from the Lake Survey Center. With this information, whenever there is a likelihood of strong, sustained winds over the lakes, forecasters are ready to provide computer-assisted predictions of storm surges in advance of the rising water. These Lake Shore Warnings, indicating that flooding or erosion is expected in a given area in 6 hr or less, are transmitted on Weather Service teletypewriter circuits for relay to the public through newspapers, radio, and television. NOAA's VHF radio weather broadcast facilities--located at Buffalo, Erie, Cleveland, Sandusky, Detroit, Chicago, and Milwaukee--carry the warnings on a round-the-clock basis on 162.55 or 162.40 mHz.

Federal, State, and local agencies are continuing their cooperative preparedness programs to minimize death and destruction from Great Lakes flooding. The U. S. Army Corps of Engineers has invested $30 million this year for dikes and other temporary protective works, principally for Lakes Erie and St. Clair and also for Lakes Michigan and Ontario. Other Federal agencies involved, in addition to NOAA's National Weather Service and Lake Survey Center,

include the U. S. Coast Guard and the Department of Housing and Urban Development's Federal Disaster Assistance Administration, which will take over if the President declares an affected community a Federal disaster area.

During the coming months, shore residents along the Great Lakes should be alert for the National Weather Service warnings, and be prepared to leave low-lying areas if local public-safety officials recommend doing so.

SUMMARIES OF DURATIONS OF HIGH WINDS ON THE GREAT LAKES

The EDS National Climatic Center has developed a computer program to produce climatological summaries of the durations of high surface winds in the Great Lakes area. Jointly funded by EDS and NOAA's National Weather Service, the effort was prompted by the record high water levels that have prevailed on the Great Lakes during the past year. The high water levels have increased greatly the potential for damage to lake shore areas from wind-driven waves and run-up. The high wind summaries are expected to be used in long-range planning for construction on shore, and as background material in providing accurate warnings before and during high winds.

Using hourly surface winds as input data, the NCC program provides tables of the number of occurrences of durations (in 1-hr intervals) of speeds greater than or equal to 15, 20, 25,...45 kt. A more detailed breakdown of durations by speed (7 categories above) and by direction (16 categories) can also be produced. To date, summaries have been prepared for four stations in the western Lake Erie-Saginaw Bay area, namely, Toledo, Ohio; Detroit, Mich.; Oscoda/Wurtsmith Air Force Base, Mich.; and Mt. Clemons/Selfridge Air Force Base, Mich.

TROPICAL CYCLONE PROBABILITY DATA AVAILABLE

The Environmental Data Service's National Climatic Center in Asheville, N.C., has printed Volumes I, II, and III of North Pacific Tropical Cyclone Probabilities containing information on 24-hr, 48-hr, and 72-hr storm movements. Computations of the probabilities were supplied by the NOAA Office of Management and Computer Systems, Systems and Applications Division, at Suitland, Md. The project was funded by the Naval Weather Service Command.

NOAA SCIENTISTS OBTAIN UNIQUE LOOK AT HURRICANE "COLD WAKE"; POSSIBLE BENEFICIAL EFFECT OF DESTRUCTIVE STORMS

Recent airborne measurements of a peculiar, possibly beneficial phenomenon--the cold sea-surface temperature wake left by some hurricanes--taken by NOAA should help scientists explain where and why cold wakes occur, and what their consequences are. They should also improve scientific understanding of how much heat flows from the sea into a hurricane, and how these great storms manage their budgets of heat energy. The research flights sampled two autumn hurricanes--Ellen in the Atlantic and Irah in the eastern North Pacific.

Cold wakes may be beneficial in certain areas. Cold water brought to the surface may be rich in nutrients which can attract enough marine life to create a kind of transient fishery behind the hurricane. The phytoplankton (drifting microscopic plant life) standing crop near the surface nearly doubled after the passage of a hurricane in the Gulf of Mexico, according to a study carried out some years ago.

Hurricanes are giant heat engines, driven by heat carried into the storm by evaporation, conduction, and convection from the warm tropical ocean. This upward heat transfer into the hurricane, caused by the surface interactions beneath the violent storm, should result in a somewhat deeper mixed layer (the upper constant temperature layer of the ocean) and a somewhat cooler sea-surface temperature over the areas affected by the storm. But there have been indications from computer models and measurements made in 1971's hurricane Ginger that changes in sea-surface temperature and mixed layer structure beneath a hurricane are much greater than can be explained by evaporation alone.

Apparently, divergence (or spreading) of surface water at and beyond the peak wind region of the hurricane may lead to upwelling of cooler subsurface waters near the storm center of such a magnitude that the thermocline--the persistent thermal boundary between the isothermal mixed layer and much colder lower levels of the ocean--may be brought to the surface. Moreover, although this effect may be limited to the immediate vicinity of the hurricane center, high winds throughout the hurricane may act to bring additional cool water to the surface over a larger area by another mechanism: mechanical mixing of cold subsurface water upward and warm surface water downward. These processes may be of sufficient magnitude to decrease the normal heat transfer to the hurricane and affect its intensity.

Because a cold wake behind a hurricane can persist for several weeks, it may affect the motion and intensity of other hurricanes approaching or crossing the wake. The position and temperature of a cold wake could be of importance to hurricane forecasters.

Cold wakes are not always produced by hurricanes, however. Their production is critically dependent on the storm's speed and the ocean's mixed layer structure and, to a lesser extent, on storm intensity.

As a result of the recent hurricane research, some evidence was found that internal gravity waves--similar to the surface waves produced by a ship's wake--are generated on the thermocline by fast-moving storms like Ellen when the ratio of storm speed to the pre-storm gravity-wave speed in the ocean exceeds a critical ratio.

When the ratio is greater than the critical value, the upwelling and mechanical mixing effects begin to decline and the production of internal waves increases. The larger the ratio, the shorter the wavelength of the internal waves and the smaller the residual sea surface cooling caused by the storm. On the other hand, when the ratio is smaller, the importance of upwelling and mechanical mixing becomes greater with the energy of the storm bringing colder water to the surface instead of producing internal waves.

The NOAA scientists met hurricane Ellen in late September, 650 mi northeast of Bermuda, and made a series of low-level penetrations through the storm at altitudes ranging from 400 to 1,500 ft, measuring

Figure 27.--Wind-whipped waves churned Atlantic waters when hurricane Ellen was photographed by NOAA's research aircraft.

winds up to 95 kt--the highest ever recorded by an aircraft flying that low in a hurricane. NOAA's C-130 aircraft, equipped with an infrared thermometer and an airborne bathythermograph system, collected sea-surface and subsurface temperature readings within the high wind region of the hurricane. Sea-surface photographs were also obtained and will be used to infer departures of surface wind velocity from flight-level wind velocity (fig. 27).

To measure the upper ocean temperature structure to a depth of 1,000 ft within the high-energy core of Ellen, as well as in her wake, the C-130 dropped 18 bathythermographs. These devices consist of a small buoy, about 4 ft tall, which floats on the water after being ejected from the aircraft, and from which a highly sensitive temperature probe deploys and descends through the water, relaying continuous temperature readings back to the floating buoy along a thin wire. The buoy then radios the temperature readings to the airplane as it continues on its flight. The bathythermographs were dropped approximately every 10 mi along two tracks: one perpendicular to the storm track, crossing the track about 60 mi behind the center, and one along the storm track from the center to a point 70 mi behind the storm. Continuous sea-surface temperatures beneath Ellen were also measured with two different infrared thermometers on the DC-6 research aircraft at an altitude of 500 ft above the ocean surface.

Results of the Ellen experiments appeared to confirm the existence of internal gravity waves in the wake of the storm and revealed only a 1° to 2°C cooling of the sea surface mostly to the right of the storm track, a result consistent with the fast forward speed of the storm at the time of the flight (nearly 20 kt).

To collect additional data on the effects of hurricanes on sea-surface and underwater temperatures, scientists traced the path of hurricane Irah, southwest of Mazatlan, Mexico, also in late September. This part of the project was financed in part by the Office of Naval Research. Using a Piper Twin Comanche, the track of the storm was traversed 3 and 5 days after occurrence. Also equipped with an infrared radiometer to measure sea-surface temperatures, the Twin Comanche dropped 30 airborne bathythermographs designed to record underwater temperatures

to a depth of 3,000 ft.

Initial results from Irah, a slower moving storm than Ellen, indicate only a slight cooling of 0.5° to 1°C to the right of the storm track, with some indication of an as-yet-unexplained warming over the center of the storm track from 1° to 2°C.

NEW YORK P. M. O. RECEIVES AWARD

Walt Stoddard, Port Meteorological Officer in the Port of New York, was the recipient of a Bronze Medal Award from the U. S. Department of Commerce, in recognition of his many years of outstanding work in the merchant ship meteorological program. Since the early 1960's, Walt (fig. 28), better known as "Red," has been a familiar face to ships' officers, whether they were berthed on the North River, Brooklyn Waterfront, or the new container ports in Newark.

Unknown to many of his friends were his years spent as a Navy Aerographer's Mate in China during World War II. After the war, he tried a tour with the Post Office, but the lure of weather and the sea persisted.

He joined the Weather Bureau and became a Weather Bureau Observer, serving aboard Coast Guard cutters on the North Atlantic Weather Patrol. He rode out one memorable storm in the Davis Strait which sent the Coast Guard Cutter McCULLOCH to the shipyards for extensive repairs. This undoubtedly contributed to his decision to apply for the position of Port Meteorological Officer in New York late in 1959.

Over the years, Walt has become "Mr. Weatherman" to the New York maritime industry. Always ready to carry a last letter ashore to mail or spend an hour explaining the intricacies of weather to a new junior mate, Walt Stoddard has earned the respect and approval of ships' officers visiting the Port of New York.

We congratulate him on this splendid achievement.

Figure 28.--Walt Stoddard, New York Port Meteorological Officer, received the Bronze Medal Award for his outstanding work in the cooperative ship program.

LETTERS TO THE EDITOR

SPECTACULAR WELL BURNOFF OBSERVED OFF INDONESIA

This interesting letter was received from Chief Officer Loren M. Smith of the PRESIDENT ADAMS. He also included two outstanding illustrations--a plot of the ship's track, showing the location (fig. 29), and a drawing illustrating the phenomenon (fig. 30). The correspondence was forwarded to the Environmental Quality Weather Services' Branch of the National Weather Service for comment. Richard C. Przywarty of that office submitted the explanation which follows Mr. Smith's letter.

"This report is offered as an example of the type of man-made meteorological phenomenon which is becoming more common in the area around Indonesia and Southeast Asia.

"Although a partial explanation can be derived for parts of what was seen, it suggests a more thorough analysis by someone on your staff--for our benefit as well as those of a deep-water environment who also read the Mariners Weather Log and who have sighted the same or similar occurrences at one time or another.

"On the passage from Port Klang, Malaysia, to Colombo, Sri Lanka, the PRESIDENT ADAMS had just rounded Diamond Point (Tandjung Djambuair). This is a prominent point on the north coast of Sumatra with a good light. The date was May 26, a little before 2130 in the evening. A faint glow had appeared earlier, in the west, and now as the ship progressed further along, it could be seen that the light was being caused by the burnoff from a well of some sort, on the shore. The ship's position was fixed each half hour

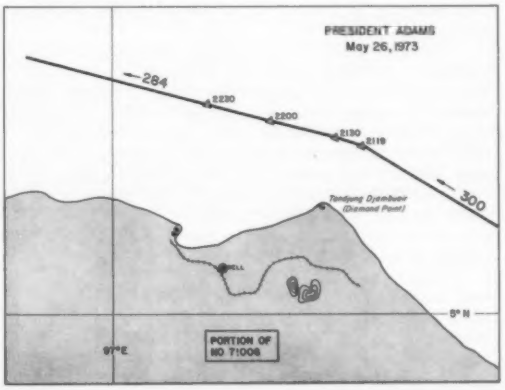


Figure 29.--Track of the PRESIDENT ADAMS when the ship encountered the burnoff meteorological phenomenon.

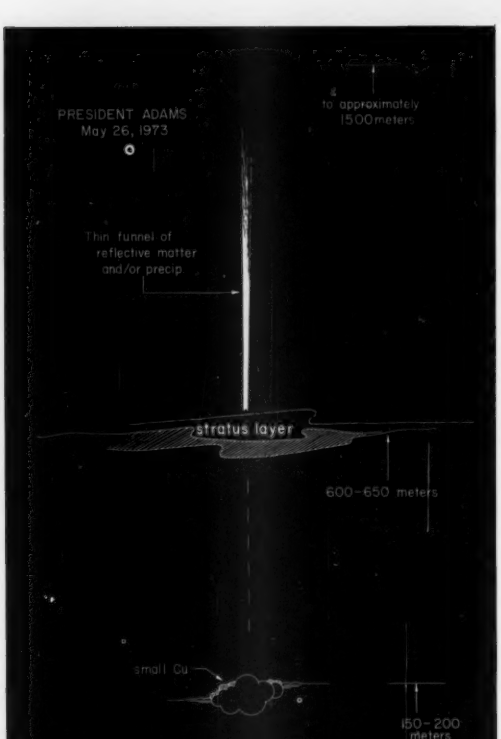


Figure 30.--Burnoff phenomenon as witnessed aboard the PRESIDENT ADAMS.

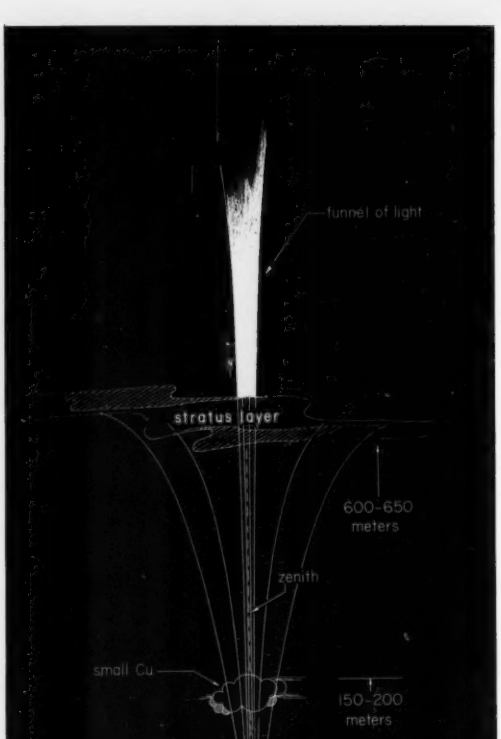


Figure 31.--Explanation of burnoff phenomenon showing paths of light rays.

and a bearing to the well plotted simultaneously. The well site was found to be located adjacent to a rail line and just a few miles to the southeast of a small harbor.

"Meteorologically, this particular event was spectacular. Directly above the burnoff, at a height of 150 to 200 m, was a cumulus cloud. Red in color, reflecting light from the flame below, it partially dissipated and reformed at irregular intervals. A thin layer of stratus was predominant over the land that night. Temperatures were 28°C (dry), 25°C (wet), and 30°C (sea/injection). The glass stood at 1010 mb and was falling slightly. There was a wind out of the WNW at force 1. The celestial dome was clear, as was the sky to seaward.

"Above the stratus layer, and directly above the well and small cumulus, a thin funnel of what appeared to be reflected light or possible condensate projected vertically to an altitude of perhaps 1500 m. The funnel or shaft of reflective matter was most prominent between 2150 and 2215. After 2230 it was no longer visible.

"The frosting on the cake that night was the Southern Cross, which hovered over the area like a supervising foreman making certain the operation was going properly--which it was. Millions of units of potential energy were escaping into the atmosphere."

Richard C. Przywarty's analysis of the phenomenon follows:

"The 'meteorological phenomenon' mentioned by Mr. Smith is indeed spectacular. The small cumulus cloud, forming at 150 to 200 m, would have been formed from locally rising air near the burning well. The upward flow would be reinforced by downslope flow from the local terrain. This cloud was probably not directly over the well, but somewhat behind, in Mr. Smith's drawing.

"The stratus layer at 600 to 650 m is an indication of a basically stable atmosphere above the small cumulus cloud.

"Figure 31 is an illustration showing the physical principle involved in forming the 'thin funnel' of light. If we make the assumption that light travels in a wave form, continually expanding from the source, much like a pebble dropped into a still pond, then the answer is readily apparent. Light waves, like sound waves or

water waves, can be represented by 'sound rays.' A sound ray is an imaginary line, always drawn perpindicular to the wave front. However, unlike our water waves, light or sound waves are rarely perfect circles. Their shape depends on several atmospheric parameters (e.g., temperature, wind, humidity, etc.). In the diagram, the light rays are shown curving, due to changes in these parameters, initially toward the zenith and then away from the zenith. When these rays intercept the stratus layer at various angles, they must travel along different path lengths. The rays intercepting the layer with perpendicular interception angles have less cloud layer to pass through, i.e., the part of the layer directly over the burning well. These rays have a much better chance to penetrate the layer because of their shorter path length. Light rays with longer path lengths are attenuated and never penetrate the stratus layer. The light would be visible above the layer because it would be reflected by water droplets above the layer, not yet large enough in size or number to be normally visible themselves.

"This balance of atmospheric parameters is very delicate, and one change--such as a surface inversion due to evening cooling--and the funnel is no longer visible.

"I agree with Mr. Smith that this type of meteorological phenomenon is indeed spectacular."

MARINE WEATHER REVIEW

Smooth Log, North Atlantic Weather

July and August 1973

The SMOOTH LOG (complete with cyclone tracks [figs. 36-39], climatological data from U. S. Ocean Station Vessels [tables 5, 6, and 8] and gale [tables 7 and 9), is a definitive report on average monthly weather systems, the primary storms which affected marine areas, and late-reported ship casualties for 2 mo. The ROUGH LOG is a preliminary account of the weather for 2 more recent months, prepared as soon as the necessary meteorological analyses and other data become available. For both the SMOOTH and ROUGH LOGS, storms are discussed during the month in which they first developed. Unless stated otherwise, all winds are sustained winds and not wind gusts.

SMOOTH LOG, JULY 1973--The predominant feature in the North Atlantic this month, on every chart, was the large Bermuda-Azores High. It took up residence in midocean, and could not be evicted, although it wandered around the neighborhood.

Cyclone activity was normal in the northern ocean and slightly above normal in the Hudson Bay-Davis Strait area. Most individual centers were short-lived, except for one that began a journey in North Dakota, on the 24th and ended over the Faeroe Islands on August 2. The storms from central Canada and Hudson Bay generally remained in the Western Hemisphere. Only a few hardy ones made it east of Kap Farvel, and then only to be lost at sea.

The U. S. East Coast was very quiet, with only one significant extratropical storm. The majority of the storm centers were north of 55°N and had a northerly track once they neared the Davis Strait or the Norwegian Sea.

The mean pressure pattern for the month was a near carbon copy of the climatological pattern. The main feature was the Bermuda-Azores High, centered in the central Ocean. The mean pressure value of 1029 mb was about 4.4 mb higher than normal. The center was located near 40°N, 36°W, or about 500 mi northeast of its normal position at 35°N, 44°W. A 1007-mb low-pressure center was near Cape Chidley. This was within a few miles of the 1008.6-mb climatic center. The actual pressure gradient between the two mean centers was slightly less than 80 mi/mb, compared to the climatology mean of about 115 mi/mb. The pressure over the eastern United States and western Europe, including the Mediterranean Sea, was near normal.

The only major anomaly was a positive 6-mb center in the central North Atlantic, near the High center. This huge positive anomaly stretched from shore to shore, and from the Tropics to Iceland. A positive 5-mb anomaly was located over the Barents Sea, and a positive 2-mb, over central Greenland. The negative anomalies were small and widely diffuse. The two major ones in the vicinity of the North Atlantic were only negative 3-mb pressure variations. One was centered over the Sahara Desert, near Mali, and the other was in the Greenland Sea, north of Jan Mayen Island.

Slightly less than one tropical cyclone occurs each year, on the average; 34 in the last 42 yr. Half of these will develop to hurricane strength. This year it was hurricane Alice, which formed on the first day of the month. A discussion of North Atlantic tropical storms for this year is contained in the article, "North Atlantic Tropical Cyclones, 1973," on page 8 of this issue.

This was a quiet month for most ships in the North Atlantic, 46 kt being the maximum winds, associated with extratropical cyclones, reported this month.

Most of the LOWs were small, relatively weak, and had short lifespans.

The first LOW that developed gale-force winds was analyzed south of Cape Sable, on a cold front on the 12th. The front stretched southward out of a LOW in northern Quebec. A long trough stretched to the south with the front, and a 1000-mb LOW formed. At 1200 on the 12th, the center was near 42.5°N, 64.8°W. South of the center, near 40.3°N, 61°W, the CITY OF OTTAWA reported 40-kt gales with 13-ft seas and 16-ft swells. At 1800, the EMPIRE STATE measured 40-kt winds and 18-ft seas, near 40.6°N, 58.5°W. At 0000 on the 13th, the center moved over Prince Edward Island, and the NORMAN MCLEOD ROGERS, just north of Sydney, N. S., had 35-kt winds and 16-ft seas.

By 1200 on the 13th, the two LOWS merged over Labrador into one 990-mb LOW. As the LOW moved northward, the frontal system pushed eastward, passing off St. John's, Newfoundland, late on the 13th. At 0000 on the 14th, SEDCO I also had 35-kt winds, prior to frontal passage.

This was now a large LOW covering most of eastern Canada, from Hudson Bay to Greenland. As the LOW moved to the north and then northwestward, another LOW moved south of it on the 14th. It had moved eastward across Canada via Lake Winnipeg and James Bay. As the front moved into Lake Superior on the 12th, the ARTHUR M. ANDERSON reported 38-kt gales near Duluth. On the 14th, after the front had passed and the LOW was east of James Bay, the LEON FALK JR. measured 35-kt winds over the central lake. By the 16th, the second LOW had also curved north and then northwestward, and the two combined south of Frobisher.

On the 12th and 13th, a ridge of high pressure extended northeastward over the United Kingdom from the stationary HIGH northwest of the Azores. This ridge separated two low-pressure systems, one located between Greenland and Iceland and another over Spain. On the 13th, the HAMBURGER BRUCKE off Portugal was headed into a 40-kt gale. Later in the day, the ridge retreated rapidly, leaving an area of weak gradient between Iceland and Spain. A front which had been pushing against the ridge moved eastward, and on the 14th a wave formed near 46°N, 13°W. A 1001-mb LOW also developed at 55°N, 15°W. This circulation pulled in colder northern air, and the system intensified as it moved eastward. At 1200 on the 15th, (fig. 32), the STAGHOUND reported 40-kt northerly winds at 49°N, 18°W. The ELBE, off Lisbon, contended with a thunderstorm.

The front moved on southeastward over the continent, but the LOW which had absorbed the wave held back over England. At 0600 on the 16th, the ATLANTIC FOREST reported 46-kt winds at 47.4°N, 15.7°W. This was the highest wind speed associated with an extratropical storm that was reported this month. Southwest of Ireland, the AMERICAN ARCHER, headed home, was discomforted by 40-kt northerly winds on her starboard side. The seas were running 10 ft and the swell 18 ft. Almost due south, Ocean Station Vessel "K" was washed by rain driven by 35-kt gales. She had 16-ft waves.

Figure 32.--The center of the LOW is over the English Channel. The STAGHOUND was almost due west of the center.

On the 17th, the 998-mb LOW moved over Norway, and the PRESIDENT EDWARD JAMES ROYE had 35-kt gales off the coast. The LOW visited Sweden on the 18th and Finland on the 19th.

This was the only LOW that tracked most of the length of the U.S. East Coast. It had its inception as a 1009-mb wave over North Carolina on the 16th. Late that day, it moved off Cape Hatteras and developed a tight circulation. By 0000 on the 18th, the 1010-mb LOW was centered at 39°N, 69°W. A ship 200 mi northeast of the center was whipped by 40-kt gale winds. The LOW was being squeezed between a HIGH moving southeastward out of the Great Lakes and the permanent

Bermuda-Azores High. As it was rolled northeastward between them, it rapidly weakened, and on the 20th gave up the fight.

A front stretched like a towline from South Carolina to Lands End. Several waves rolled along it, as if someone was whipping an end. They quickly faded and were not traceable from one chart to the next. On the 24th, as the line slackened, one was able to establish itself near 45°N, 46°W. The TRAVIATA, at 42.7°N, 44.1°W, was buffeted by 45-kt gales. The LOS ANGELES was just east of the front and south of the LOW at 1200, when she was overtaken by 40-kt southerly gales and heavy drizzle. The LOW was moving northeastward and was at 50°N, 38.5°W, by 0000 on the 25th. The MUSSON was hit by 40-kt southerly winds about 70 mi east of the center, and a ship found 35-kt northerly winds about the same distance west of the center.

The 996-mb LOW was headed almost due north. Late on the 25th, the center passed nearly over the DUKESGARTH . At 0000 on the 26th, she reported 40-kt winds south of the center. Although light, the seas were very confused with swell from two directions.

The LOW moved through the Denmark Strait on the 27th, and ended its career on the 29th, north of the Svalbard Islands.

This LOW's claim to fame was its longevity. It was born on the 24th, in North Dakota, as a 1012-mb LOW. On the 26th, it moved across Lake Superior. On the 27th, the LIMNOS reported from Lake Erie and the HALIFAX on the St. Lawrence River. The LOW moved steadily northeastward, and moved offshore near Hopedale early on the 29th, with a pressure of 994-mb.

As the LOW crowded against the 1036-mb HIGH in the mid-Atlantic, Ocean Station Vessel "C" radioed a report of 40-kt winds. On the 30th, the LOW split, with one center moving up Davis Strait and the other eastward along 59°N. As the LOW moved across its top, the HIGH center moved westward. On the 31st, the LOW center passed almost directly over Ocean Station Vessel "I." The pressure had then risen to 1010 mb, and the LOW was aging rapidly. Late on the 2d, the LOW was buried on the Faeroe Islands.

Subtropical cyclone Alfa got its start in a trough of low pressure off Charleston, S.C., early on the 30th. For a discussion of "subtropical cyclones," see page 203 of the July 1973 issue of the Mariners Weather Log. The reports from many ships helped identify and locate the small but intense storm as it moved up the East Coast.

Although there were no ship reports of gale-force winds or higher, reconnaissance, satellite, and ship pressure reports indicated a small but intense circulation. The early marine warnings probably enabled shipping to avoid the storm. Winds as high as 40-kt, with gusts to 50 kt, were estimated near the center. The cyclone moved rapidly northeastward off the coast until, late on the 31st, it slowed near 39°N, 70°W. It was in this area south of Cape Cod that it reached its maximum intensity on August 1, with a central pressure of 1007 mb. By 0000 on the 2d, the storm, rapidly weakening, moved onto the coast of Maine. Six hours later, it could no longer be identified.

Reports from the following ships were directly useful in analyzing the storm: ALIAKMON, AURIVAARA, IGUAPE, IMPERIAL ST. LAWRENCE, OCEANIC, TRANSIDAHO, TRINITY, WARRIOR, and the DFQA and VSVF.

Casualties--There were two weather-related casualties. On the 4th, the 13,554-ton Cyprian carrier FLORENCE and the 22,190-ton Liberian tanker ST. SPYRIDON collided in dense fog, 180 mi northeast of Quebec City, in the St. Lawrence River. On the 28th, the 554-ton British-registered ACER capsized and sank in rough seas about 1 mi south of Dyck lightvessel, near 52°N, 2°E.

SMOOTH LOG, AUGUST 1973--This was a good month for mariners on the North Atlantic. Extratropical cyclones were near normal in number and generally weak, without good organization. The primary track in the western area was further south than normal, off the northeastern United States and Canadian coasts, rather than across Quebec and Labrador Provinces. The storm paths across Canada into the Baffin Bay and Labrador Sea area were diffuse. On the eastern side of the ocean, the primary track was more northerly, passing into the Norwegian Sea, rather than eastward across Scandinavia.

There were two tropical cyclones--hurricane Brenda and tropical storm Christine. August is generally the second most prolific month for tropical cyclones. On the average, there will be about 2.4 tropical cyclones and 1.5 will develop into hurricanes. The largest number recorded in August was seven in 1933, followed by six in 1969. This year's tropical cyclones are described in the article, "North Atlantic Tropical Cyclones, 1973," on page 8.

The pressure pattern configuration was near normal, but pressures were more intense. The Bermuda-Azores High was near its climatological position, but the center was approximately 3-mb higher. A closed 1005-mb Icelandic Low was near 60°N, 30°W. A 1017-mb High was centered over northern Greenland. The pressure along the U. S. East Coast was normal. The pressure over the eastern Atlantic and Europe was 4 to 7 mb higher than normal. This higher pressure was compatible with the more northerly storm track in that area.

The anomaly chart was mostly positive, with a few exceptions. A negative 5-mb anomaly was centered with the Icelandic Low near 60°N, 30°W. It extended like waterwings to another negative 5-mb center over Bjørnøya Island in the Barents Sea, with another negative 4-mb center over the North Pole. Positive anomalies were centered over Hudson Strait (6 mb) and northern Greenland (5 mb). The largest positive center was 7 mb, over northeastern Europe. This large positive area stretched across the central Atlantic (30°N), and included Europe, North Africa, and the U. S. S. R. to 120°E.

A general low-pressure area with several centers stretched along 60°N from southern Baffin Island to northern Scotland. On the 1st, a 1005-mb LOW was analyzed between Kap Farvel and Iceland. The circulation around this center spread,and, by 1200 on the 2d, the pressure was 997 mb, as the center remained

quasi-stationary. A front extended across the ocean from England to Nova Scotia, approximately along the 46th parallel. Minor waves moved eastward along the front. On the 4th, one wave developed enough to bring 35- and 40-kt gales to the ATKU, near 50°N, 20°W, the EWAK, near 56°N, 15°W, the PIONEER COMMANDER, at 55.4°N, 25.5°W, and the TOLUCA, near 52.4°N, 22.9°W. At 1200 on the 5th, the FRANCE, headed west near 50°N, 28.7°W, was buffeted by 35-kt gales and light seas. The 11,478-ton Liberian tanker DONA MARIKA went aground at Milford Haven, England, in heavy seas, and was reported breaking up. She was abandoned safely by her crew of 38. At 0000 on the 6th, Ocean Station Vessel "C" was riding out 40-kt westerly winds on her port side, and, at 0300, 45-kt winds, as the 986-mb LOW had drifted to 58°N, 19°W. By 0000 on the 7th, the LOW was absorbed by one of the waves moving around its perimeter and the combined system moved off to the northeast.

This LOW originated in northern Quebec on the 8th. It moved eastward and then made a sudden and swift shift to the south, to combine with a frontal wave on the 9th. At that time, the 1003-mb LOW was near Goose Bay. South of Newfoundland, the HOI ENDRECHT reported a thunderstorm and the JOHN CABOT was hounded by 35-kt gales. The LOW center tracked eastward and, at 1200 on the 10th, was near 54°N, 43°W, with a pressure of 993 mb. About 200 mi to the east, Ocean Station Vessel "C" measured 40-kt winds from the south at frontal passage. In almost a straight line south of Charlie, the AMERICAN ACCORD and the ATLANTIC CHAMPAGNE were tossed by 35-kt gales. The AMERICAN RANGER was battered by 40-kt gales, 8-ft seas, and 13-ft swells at 51.3°N, 33°W.

The center then turned northward and, late on the 12th, passed over Iceland. At 1200 on the 13th, the URYX, south of Iceland, reported being hit by 40-kt gales, as the storm took its last swipe at shipping before disappearing in the Norwegian Sea.

The genesis of this storm was in the midwest on the 14th. On the 16th, it moved off the coast and, by 1200 on the 17th, the 1009-mb LOW was at 42.5°N, 57.5°W. On the 19th, another LOW formed off St. John's, Newfoundland, and on the 20th the two combined. A ship was pounded by 45-kt winds near Belle Isle. At 0000 on the 21st, the RAEBURN was hit by 35-kt northeasterly gales, 200 mi northwest of the 988-mb center. Twelve hours later, Kap Farvel was blown by 40-kt gales, and the AMERICAN ACCORD was hit with the same force, plus 15-ft seas, at 49.7°N, 32.6°W, at 1800. On the 22d, the LOW stalled near 58°N, 35°W and started to fill. On the 23d, another LOW approached from the south and absorbed the old center on the 24th.

The same frontal system associated with the previous LOW was the progenitor of this storm. The front was quasistationary across the Carolina coast for several days. Minor waves developed over and off the coast, from the 17th through the 19th. By 0000 on the 20th, one had enough strength to survive and develop over the Gulf Stream near 39°N, 65°W. At 2200 on the 21st, the NEWARK, near 40.5°N, 53.3°W, was pounded by 56-kt winds and 20-ft seas. At 0000 on the 22d, the LOW was located near 40.5°N, 52.5°W, with a pressure of 997 mb. The OLGA MAERSK, very near the center, recorded 40-kt northeasterly winds.

The storm continued on a northeasterly track until the 23d, when it turned northward. Several other LOWs were involved with the major circulation, so the wind speeds were not significant. After turning toward the north, the LOW continued to deepen, and, at 0000 on the 25th, had a pressure of 978 mb, near 60.5°N, 34°W. No ships reported in the area of tightest gradient. Early on the 26th, the LOW was stationary and surrounded by three other LOWs. By late in the day, the four had combined into two.

This system only concerned the Great Lakes, and the mischief-maker was the cold front, not the LOW directly. A LOW was moving eastward across the Northwest Territories, with a cold front extending almost due south in a sharp trough. The front moved across Duluth about 1800 on the 19th. The strong winds were behind the front.

At 0600 on the 20th, the J. L. MAUTHE was on the eastern end of Lake Superior and measured 38-kt gales from the west-northwest. Twelve hours later at 1800, when the JOHN DYKSTRA was in northwestern Lake Huron, she measured 37-kt winds from the same direction. A small wave had developed on the front as it crossed the lakes. At 0000 on the 21st, the LEON FALK, north of Saginaw Bay, and the JOHN SHERWIN, in Whitefish Bay, had 36- and 45-kt winds, respectively. The SHERWIN experienced 8-ft waves, The present weather in all these cases was coded 01 and 02; clouds generally becoming less developed and state of sky unchanged, on the whole.

The front continued to move eastward, with high pressure moving over the lakes on the 22d.

The nemesis of sailors--Cape Hatteras--was the birthplace of this storm. A LOW developed early on the 22d and moved up the East Coast, deepening rapidly as it went. At 1200 on the 23d, the 1001-mb center was southeast of Nova Scotia. At 0000 on the 24th, the small, intense storm was over the Grand Banks and gale winds were reported in all quadrants. The SEDNETH and STIRLING BRIDGE were both lashed by 45-kt winds south of the center. The DART AMERICA, to the north, found 40-kt winds and the SEDCO, to the east, was pounded by 35-kt gales.

Twelve hours later, at 1200 on the 24th, the winds at the SEDCO's position had shifted almost 180° and increased to 45 kt. The ANSGARITOR, about 350 mi southwest of the center, was bounced by 40-kt northwesterlies, and the KOREA RAINBOW, about the same distance to the south, had 35-kt shifting winds as the front passed. Her location was very near the frontal occlusion.

On the 25th, the storm took a northward track, but much of its energy was sapped by other LOWS in the area. Another LOW, moving eastward out of Hudson Bay, would absorb this LOW. As it moved south of Kap Farvel, the FNJF, which had been stationary near 54°N, 55°W for several days, reported 40-kt gales.

This storm formed a few miles south of the Newfoundland coast on the 29th. It rapidly moved northeastward and, at 1200, the CETRA COLUMBIA

and another ship reported 35-kt gales along the front. The 984-mb storm moved northeastward, and the IDEFJORD was rolled by 35-kt winds on her port side. The IRISH STAR, far to the south, near 35°N, 54°W, along the front, reported only 30-kt winds at 0000 on the 30th, but at 0300 she was hit by 52-kt northwesterly winds with a moderate rainshower. At 1200, the AMERICAN ALLIANCE, near 50.6°N, 44.3°W, found 40-kt gales. Three hours earlier at 0900, Ocean Station Vessel "B" had 40-kt winds, and Ocean Station Vessel "C," 45-kt winds. Both reported 11.5-ft seas.

At 0000 on the 31st, the pressure had dropped to 980 mb, near 59.5°N, 35°W. The BUCCLEUGH had 40-kt gales. At 1200, the 976-mb center was at 61°N, 32°W (fig. 38). The DANA, near 63.5°N, 33°W, was washed by heavy rain blown by 50-kt winds. The FRIDA DAN, about 100 mi off Kap Farvel, and the MANCHESTER CRUSADER, about 200 mi further southeast, had 35-kt gales. Sea and swell were running 15 to 20 ft in the area. Six hundred miles to the southeast, Ocean Station Vessel "J" and the WEATHER SURVEYOR were both bothered by 35-kt winds near the front.

As the center moved just south of Iceland on September 1, the DANA still had 40-kt gales and 25-ft seas. The FRANCE I, south of the center, also found the 40-kt wind band. At 1200 that day, Ocean Station Vessel "I" bucked 35-kt gales and 15-ft seas to stay near station. The LOW continued northeastward until the 3d, when it stalled off the Norwegian coast and filled.

Casualties--A 28-ft cabin cruiser broke up and sank after hitting a jetty at Shinnecock Inlet on Long Island, in heavy seas and fog. Waves at the mouth of the inlet were reported to be 8 to 10 ft high. The British passenger liner CANBERRA (44,807 tons), with 1,800 passengers, dragged her anchors in a squall, and was driven onto soft sand off St. Thomas, Virgin Islands. No damage or injuries were sustained. The 2,532-ton Cyprian VIKI sank in the Mediterranean, at 37.8°N, 8°E, after a collision with the Greek GREBBESTROOM in thick fog. The GREBBESTROOM rescued the crew of the VIKI.

Smooth Log, North Pacific Weather

July and August 1973

SMOOTH LOG, JULY 1973--Extratropical cyclones activity was at a minimum, but tropical cyclone activity was at a maximum this month. The storm tracks followed the climatology pattern only in the broadest sense. The path with the most activity originated well east of Japan. A northern part diverted into the Bering Sea, while a secondary southern track was well south of the Gulf of Alaska. All in all, the tracks were diffuse, with no primary path.

The 1026-mb Pacific High was the dominant pressure feature. Its shape was more elongated than the 1026-mb egg-shaped climatology High. A 1011-mb LOW was centered near 47°N, 163°E. A small trough penetrated the top center of the Pacific High, south of the Alaska Peninsula. A 1003-mb LOW was centered over the Arctic Ocean near 83°N, 170°W.

The largest anomaly was a minus 8 mb, in association with the LOW over the Arctic. In the main North Pacific area, "4" was the favorite number. Two negative 4-mb anomalies were located at 45°N, 168°W and 48°N, 153°W. A positive 4-mb anomaly was centered off Portland, Oregon. A long, narrow positive anomaly extended the length of the U.S. West Coast, from Baja California to Alaska.

This month totaled 11 tropical cyclones in the North Pacific--4 in the eastern ocean and 7 in the western ocean. In the eastern area, three of four reached hurricane strength. In the western area, four of seven reached typhoon strength. Only one other year exceeded this number of tropical storms in the North Pacific during July--1971, when 15 were recorded, 8 in the west and 7 in the east. Since 1945 only 2 other years have tied this number of tropical storms during July--1964 and 1972.

A new record was also set in the western North Pacific, when the first tropical cyclone of the year did not occur until Wilda formed on July 1. During an average July, tropical cyclone activity is centered on either side of the northern Philippines. In this respect, this July was average. Two typhoons and a tropical storm formed in the Philippine Sea, while two typhoons and a tropical storm developed over the South China Sea. A seventh tropical cyclone, a weak storm, formed in the mid-Pacific.

The names of the storms are as follows--eastern North Pacific: hurricanes Doreen, Emily, and Florence, and tropical storm Glenda; western North Pacific: tropical storm Wilda, typhoon Anita, typhoon Billie, tropical storm Clara, typhoon Dot, typhoon Ellen, and tropical storm Fran.

The first week of the month, only weak, diffuse extratropical Lows were present. The Pacific High was spreading and, on the 7th, covered the entire North Pacific from Japan to California, and 15°N to the Bering Strait. An old, weak front stretched from shore to shore, slightly north of the center of the HIGH.

On the 8th, a 1014-mb wave developed on the front near 49°N, 175°E, on the northwest side of the HIGH. By 1200 on the 9th, the 998-mb LOW had crossed the top of the HIGH to 54.5°N, 167.5°W. King Cove, on the Alaska Peninsula, reported 35-kt gales. At this point, the storm stalled and looped around Unimak Island on the 10th and 11th. The ZAWA MARU, in the Bering Sea, found a 35-kt norther on the edge of the storm. The MIDAS RHEIN, at 52.5°N, 176.3°E, measured 39-kt gales. On the 11th, the PRESIDENT MADISON, 450 mi south of the center, found 35-kt gales.

As the LOW came out of the loop, it moved to the southeast, as far south as 50°N, and a 1036-mb HIGH

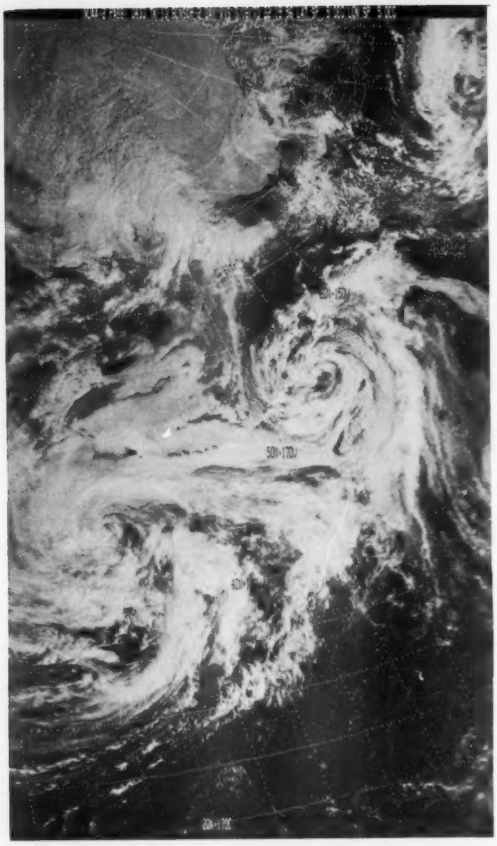


Figure 33.--The storm is located near 47°N, 167°E, in this satellite picture. Ships reported strong winds in all quadrants. Another large LOW is south of the Alaska Peninsula.

crowded closer to the California-Oregon coast. The normal summer heat LOW near the California-Nevada-Arizona border did not budge, and the winds increased off the coast. The ARGYLL reported 35-kt gales on the 11th, and the PLUTOS was windswept by 40-kt gales on the 12th. The high pressure was too much for the storm, and it again turned northeastward, dissipating over Alaska on the 13th.

Monster of the Month--This storm system was out of former tropical storm Clara, by a 1006-mb LOW to the north. On the 15th, these two produced a single 990-mb LOW near 38°N, 172.5°E. The VIVARIAS was the first to clock the young colt, at 55 kt. On the 16th, as the 982-mb LOW moved northwestward, several other touts were around the track. The TOYOTA MARU No. 18, close to the center, was whipped by 50-kt storm winds, accompanied by 16-ft seas and swells. In the grandstands (42°N, 179°W), the TAIO MARU had 40-kt gales off her port side. The LEIDENSCHAFT and the PRESIDENT MCKINLEY both rode out 35-kt winds. The GOLDEN BEAR, on the northeast side of the LOW, measured 50-kt winds and battled 33-ft seas (fig. 33).

The LOW was then in the process of completing a lazy "S"-shaped track, and she did the unusual by moving southwestward, then again turning to the north on the 17th and 18th. The ALEX SERAFINOVICH bucked 40-kt headwinds on her easterly course, north of the center. This backstretch of the track continued to be fast, as the HONSHU MARU and another ship reported 35- and 40-kt gales south of the Aleutians.

As the storm moved northward toward the Near Islands, its pressure started to increase and the winds decreased. By the 20th, when it circled southwest of Attu, the pressure was 998 mb and continued to increase, as it moved into the Bering Sea. On the 23d, in Bristol Bay, the old nag went to that pasture in the sky.

Late on the 21st, a ripple appeared on the polar front on the west side of the Pacific High. By midday of the 22d, it was a 998-mb LOW, at 38°N, 156°E. Early on the 23d, a second circulation started to develop in the south, as the LOW moved north, but it could not withstand the pressure of the two HIGHS on each side. The SEALAND TRADER, at 45.7°N, 169.3°E, had 41-kt gales east of the northern center. The SERGEY YESENIN and another ship could attest to its presence, by the 35-kt gales they experienced.

This LOW, like others in this area, went north for the summer for cooler weather. At 1200 on the 24th, the 990-mb LOW was at 50.5°N, 165.5°E. Far to the south, the SHINTOKU MARU was rained on and blown about by 35-kt winds. As the storm center crossed into the Bering Sea, it was like the old firehorse headed for home--it sped 850 mi north-northeastward in 24 hr. On the way, it treated the Aleutians to winds up to 35 kt. As it neared the Bering Strait on the 26th it slowed to pass through the narrow strait and join an Arctic Low in the East Siberian Sea.

Wilda began the 1973 season on July 1, near 19.3°N, 118°E. This same day, she reached tropical storm strength and headed northward. Wilda's central winds swelled to 55 kt as she approached mainland China on the 2d. She crossed the coast south of Fu-chou. Once inland, Wilda dissipated.

While Wilda wilted, Anita blossomed in the South China Sea. By the 6th, she was a tropical storm about 80 mi off the South Vietnam coast, near 14°N. The next day she was a typhoon. Some 300 mi southeast of her center, the G8FA ran into southwesterly gales. Close to her center, winds were 75 kt, with gusts of 110 kt. Anita remained a typhoon when she crossed the coast, near Ben Thuy, on the 8th. She dissipated slowly, as she moved toward northern Laos.

The weather was quiet for a few days. On the 13th, things broke loose. The embryos of three tropical cyclones were sighted. Billie developed east of Luzon. She was a typhoon the following day, and peaked by the 15th. Winds of 120 kt, with 160-kt gusts, blew around a 945-mb center. The PRIBOY ran into 35-kt winds some 240 mi east of Billie's center. Miyakojima, on the Ryukyu Islands, recorded 101-kt winds. On the

17th, Billie roared through the Ryukyus and into the East China Sea. The KOREAN MAIL, moving northward with the storm, contended with 45-kt winds and waves of over 16 ft for more than 12 hr. On the 18th, the GENEVIEVE LYKES was battered by 50-kt winds, near 32.3°N, 128.3°E. Billie was now weakening. On the 19th, Billie moved past Shanghai, on a north-northwesterly course, and into the Yellow Sea.

While Billie was bullying the Ryukyus, Dot had developed and was threatening Hong Kong. Dot had also formed on the 13th. She had intensified quickly and also moved northward. By the 16th, she was generating 80-kt winds around her center, about 150 mi east of Hai-nan. As Dot passed close to Hong Kong, her winds diminished. Her torrential rains were responsible for landslides; one woman died in a slide. Three ships ran aground in the harbor, but all were pulled free by tugs. Dot wandered across China for a few days and emerged over the East China Sea on the 19th. The GENEVIEVE LYKES was headed southward and encountered 45-kt gales, 13-ft seas, and 16-ft swells, associated with Dot. However, she never regained her former intensity.

On July 14, Billie and Dot were intensifying on either side of northern Luzon. Their circulations combined to generate rough seas in the Philippines. These seas swamped the 1,735-ton MACTAN, a domestic passenger ship. She went down in the Tablas Strait, about 120 mi southeast of Manila. Preliminary reports indicated that 645 persons survived, 2 died, and 36 were missing.

Clara was a short-lived tropical storm that developed on the 12th, around 28°N, 162°E. Winds near her center reached 35 kt on the 13th, but she started to weaken on the 14th and turned extratropical near 32°N, 161°E.

Ellen became the first typhoon of the season to threaten Honshu. On the 19th, she was just west of the Bonin Islands. Winds near her center were 100 kt, with gusts to 140 kt. Ellen was on a northward course that would take her directly over the Japanese mainland. The VIRGINIA TRADER, at 32.9°N, 140.8°E, northeast of the storm, reported 35-kt gales. This was the only ship report with gale-force winds received in the vicinity of Ellen. Breakers of 12 ft warned Pacific Coast residents of the imminent threat. Suddenly Ellen began to weaken, and she unexpectedly turned westward, less than 100 mi south of Honshu. On the 22d, Ellen moved across southern Kyushu as a tropical depression. She brought 1 to 4 in of rain to southern Japan, but caused little damage.

Fran developed on the 29th and dissipated on the 30th. She barely reached tropical storm strength just east of northern Luzon, near 19°N, 124°E. Then, she weakened rapidly.

Hurricane Doreen began as a disturbed area near 9°N, 101°W, over the warm water off Panama, and was first seen by satellite, at 1600 on July 16. The area was in the intertropical convergence zone and showed some signs of a closed circulation. A nighttime infrared photograph, at 0400 on the 17th, showed the area was moving west at 10 kt and becoming organized. By 1800, satellite pictures placed the center of circulation near 9°N, 105°W, but reports from the KAPAA, HOEGH DYKE, and the AKADEMIC KOROLYOV indicated that the center was some 2° farther north. By this time, a tropical depression had formed, and bulletins were issued.

Development was rapid, with the AKADEMIC KOROLYOV reporting 30-kt winds at 0000 on the 18th, suggesting that a tropical storm had formed near 10.5°N, 107°W, about 120 mi east of Clipperton Island. The AMERICAN CORSAIR reported 38-kt winds and 15-ft seas at 0600, and 0600 and 0900 observations were received from the SHAMALY. An Air Force reconnaissance aircraft measured 60-kt winds at 2230 on the 18th, and at the rate of development taking place, the storm was indicated as a hurricane at 0000 on the 19th.

The hurricane was moving west-northwestward at about 12 kt. The AMERICAN CHALLENGER passed to the south during the night of the 18th. The HOEGH DYKE, heading west, passed in front of the storm between 1800 and 2100 on the 19th, reporting 40-kt winds. The SPEY BRIDGE also reported 40-kt winds. Both vessels were about 150 mi from the center. Reconnaissance aircraft at that time measured winds of 90 kt, with a central pressure of 973 mb.

Doreen continued on her course, well out of range of surface vessels. Aircraft reported maximum intensity winds of 120 kt at 1920 on the 20th; 80 kt at 1906 on the 21st; 65 kt at 1825 on the 22d; and 60 kt at 1800 on the 23d, near 15°N, 133°W. Reconnaissance priority after the 23d was directed toward hurricane Emily, nearer to the more heavily traveled shipping lanes of Manzanillo.

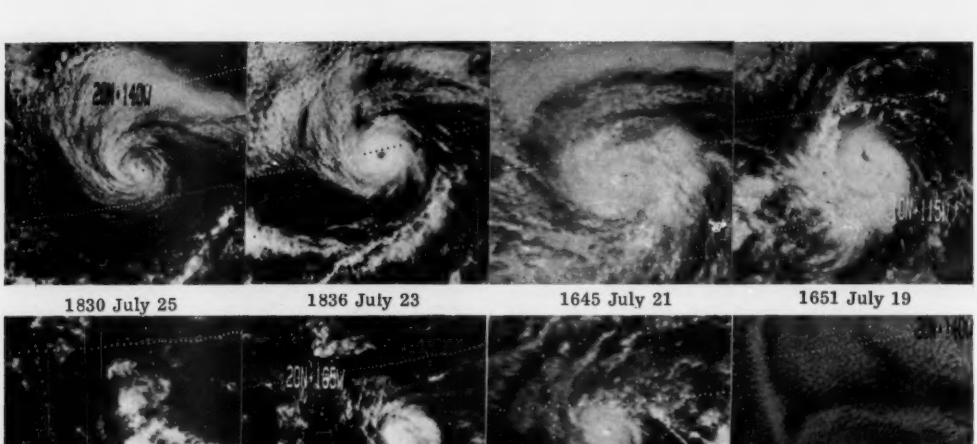
Wind speeds in the storm were in the 55- to 70-kt range after 1800 on the 23d. Doreen passed 17°N, 140°W, on a westerly course, shortly before 1800 on the 25th.

A frontal system between two portions of the North Pacific high-pressure area weakened as Doreen approached 145°W, and the two cells merged with the main center about 1,000 mi northwest of Honolulu. The main High center moved eastward, forcing Doreen southward on the 27th, to near 12.5°N, 150°W at 1800 on the 28th, after which she set a west-northwesterly course, at 8 to 10 kt.

On the afternoon of the 27th, the 144-ft Greek ship CORNELIA sailed into the storm's path and sent out an emergency call for help when it lost its rudder, while being lashed by 52-kt winds and 35-ft waves. A sea-level pressure of 971 mb was reported. The ship managed to clear the storm and continued its way to Panama, after deciding not to return to Honolulu with Coast Guard assistance.

Before the dip to more southern latitudes, Doreen was classed as a tropical storm, but regeneration developed hurricane winds again at 0000 on the 28th, which continued until 0600 on August 1. The hurricane passed 300 mi south-southwest of South Point, Hawaii on the afternoon of the 30th. On the afternoon of the 29th, 9-ft ocean swells and 3 1/2-ft surf generated by Doreen were observed at Kapoho, the easternmost point of the island of Hawaii.

West of 165°W, deterioration of the storm was rapid. Winds decreased to 60 kt near 18°N, 166°W, at 1200 on August 1; to 35 kt at 20°N, 171°W, at 1200 on the 2d; and, at 0000 on the 3d, the storm was a depression with 30-kt winds. Advisories were discontinued, and



1830 July 25 | 1836 July 23 | 1645 July 21 | 1651 July 19

2004 Aug 02 | 2008 July 31 | 1822 July 29 | 1826 July 27

Figure 34.--This series of photographs shows hurricane Doreen during part of her 4,200-mi journey, July 19 to August 2. Every second day is shown, right to left and top to bottom, as she traveled westward across the Pacific.

she dissipated in an upper air trough as she crossed the Dateline.

Doreen was an interesting storm. The sharp recurvature on the 27th and 28th, and the subsequent redevelopment to hurricane intensity, were unusual. She had a long life--18 days, covering a distance of 4,200 mi (fig. 34). She was well behaved--except for the redevelopment period on the 27th, she followed the forecast track. Throughout her life cycle, Doreen followed a strikingly similar path to that of hurricane Celeste in August 1972.

Squally weather and 40-kt winds in the Gulf of Tehuantepec, beginning July 18, were reported by the ROSEVILLE. The RUTH LYKES reported 30-kt winds. The squalls gradually organized into a cyclonic circulation and formed a tropical depression near 13°N, 96°W, at 0600 on July 21.

The squally area was nearly stationary; but, as it organized, it began moving west-northwestward at 12 kt, becoming tropical storm Emily near 14°N, 99°W, at 1800 on the 21st. Winds increased to hurricane force by 0600 on the 22d. Winds of 40 kt were reported 120 mi from the center by the EXPORT COMMERCE, the TAIAN, and the VAR, and 45-kt by the KEYTANKER, at 0600 on the 22d. At 0300, the EXPORT COMMERCE had encountered 45-kt gales.

Emily ran west-northwestward, nearly parallel to the coast and 180 mi offshore, until south of Manzanillo, where she turned to a more westerly course, leaving the heavily traveled shipping lanes. She developed 110-kt winds at 1755 on the 22d, near 15°N, 104°W, and 90-kt winds at 17°N, 108°W, on the 23d, as measured by Air Force reconnaissance planes. Gale winds were reported off the coast of Mexico, more than 300 mi to the east, between the 22d and 24th. These reports came from the ANTARCTIC CORE, EXPORT COMMERCE, HOEGH MARLIN, POMONA, TAEPING, TAIAN, and the VAR, and non-AMVER-listed vessels GLBF, ICKN, SYWG, and 4XMY. Satellite pictures indicated that Emily maintained hurricane intensity through 1200 on the 25th, then near 17.5°N, 114.5°W.

Gradual weakening then took place, with the tropical storm curving toward the northwest, until winds reached 35 kt. This strength was maintained for about 36 hr, until the center reached 22°N, 123°W, at 0000 on the 28th. Thereafter, remains of the storm were indicated in satellite pictures, and the cloudiness moved northwestward to 25°N, 125°W by August 6, before being absorbed into the northeast trades.

A disturbed area, 150 mi off Guatemala on the 25th, was moving slowly west-northwestward, curving a little toward the coast. The area was slow to develop; but, at 0600 on the 26th, the LABRADOR CLIPPER and the UNION EAST reported 30- and 35-kt winds, respectively, and indicated a cyclonic circulation about 75 mi southeast of Acapulco.

By 0000 on the 27th, reports from the ARCO COLUMBIA, GOTAMA JAYANTI, SHIRLEY LYKES, and VARICELLA indicated that the greatest activity had moved to about 100 mi south of Acapulco, with a circulation strong enough to indicate a tropical storm. A westward movement continued through the night of the 28th, as the storm slowly increased, becoming hurricane Florence at 0000 on the 29th, near 17°N, 108°W, about 200 mi southwest of Cape Corientes.

The hurricane continued west-northwestward until 2150 on the 28th, when winds reached an estimated 80 kt, according to satellite pictures. A pressure of 990 mb was measured by reconnaissance aircraft. As

the storm moved over cooler waters and into more stable air from the north, dissipation was completed in less than 24 hr, near 20.5°N, 115.5°W, by 1800 on the 30th.

Glenda developed slowly, about 300 mi off the coast of Guatemala. As a tropical disturbance, she moved west at about 12 kt, until south of Acapulco, when a closed circulation was inferred from nighttime satellite pictures, at about 0400, July 30.

At 1800 on the 30th, the MALLORY LYKES reported squalls and southerly 30-kt winds about 75 mi east of the center, and the NISSAN MARU, a north wind of 10 kt, 180 mi west of the center. An advisory was issued for a tropical storm, with winds to 40 kt, heading west-northwestward at 12 kt.

This direction of movement and speed continued through 1800 on the 5th. Winds increased to 50 kt during the night of the 31st, then decreased to the 30-kt winds of a tropical depression at 1800 on the 1st. It maintained 30-kt winds through 1200 on the 4th, near 18°N, 123°W. The TOYOTA MARU reported 40-kt winds, with a 989.3-mb pressure, at 1800, indicating that a tropical storm was still in progress. This intensity continued until 1800 on the 5th, when satellite pictures showed cool air entering the dissipating system.

Few ships reported weather in the vicinity of Glenda, through most of her life. Positions were largely based on visual and infrared satellite pictures, at about 1800 and 0500, respectively.

A correlation of eastern North Pacific storm intensity with satellite pictures is a continuing program that can only be successful if vessels experiencing storm conditions send weather reports to "METEO WASHDC." Use the preferred format, preceded by the word "STORM."

Casualties--The 1,215-ton Japanese ferry MURORAN MARU and the 4,736-ton Philippine cargo ship SANTA ANA collided in fog on the 1st, in Tsugaru Strait, with no injuries. The 998-ton HOSEI MARU sank off Taitosaki Light, after colliding with the HOKKO MARU in fog on the 6th. The crew was rescued. The Panamanian-registered motorship EASTERN DIAMOND (8,213 tons) developed a 30° list after a collision with the Japanese-flag ore carrier RYUSHO MARU (11,612 tons) in thick fog, 680 mi east of Nemuro, Japan. The 1,736-ton Philippine-registered MACTAN encountered heavy weather on the 15th, off Pucio Point. The vessel sank on the 16th. Five passengers were reported dead and 17 persons missing. The Russian trawler NAKHODKA (fig. 35) (3,170 tons) required repairs to her bow after a collision with her sister ship, the SEZD ULKSM (278 ft), which sank. One hundred and fifty were reported rescued.

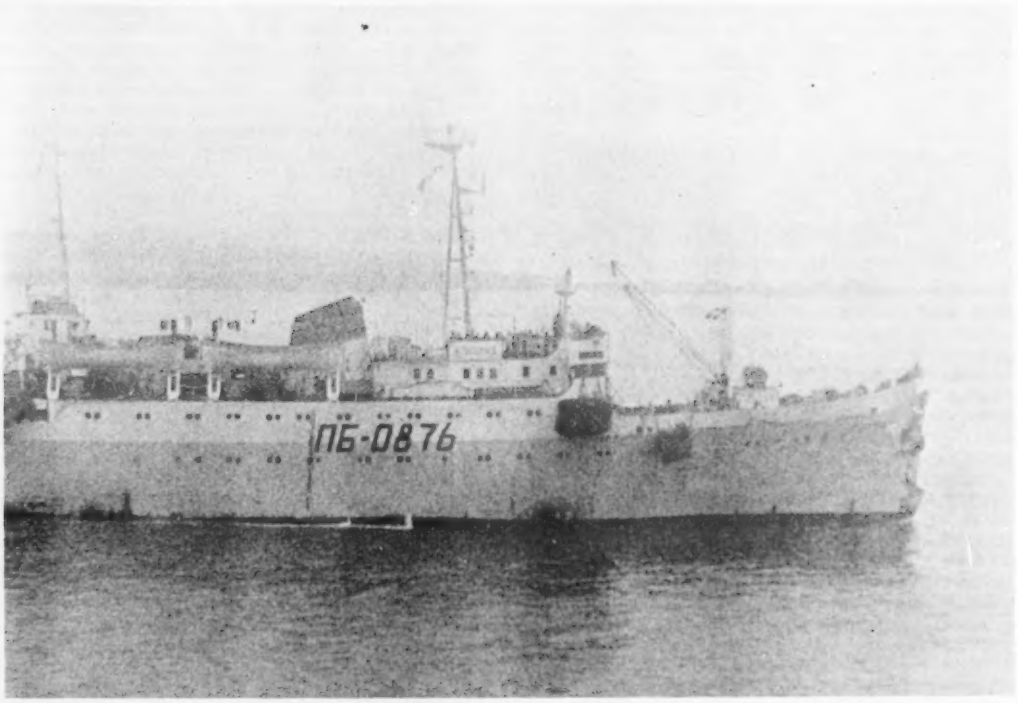


Figure 35.--The battered bow of the NAKHODKA can be seen through the fog, as she enters Coos Bay for emergency repairs. Eugene Register-Guard Photo.

SMOOTH LOG, AUGUST 1973--Extratropical cyclone activity was below normal in the North Pacific this month. The primary climatological storm track from southern Kamchatka Peninsula to Seward Peninsula was closely followed by the actual tracks, but there were fewer storms. A second primary track from Japan to the Gulf of Alaska was further south than its climatological counterpart, which passes near the Pribilof Islands. The storms along this path were primarily late in the month, relatively few in number, and short lived.

There were five tropical storms in the western North Pacific and one in the eastern North Pacific. In the west, there were typhoons Georgia and Iris, and tropical storms Hope, Joan, and Kate; in the eastern ocean, tropical storm Heather.

The shape of the mean pressure pattern was near the climatological normal. The average pressure was higher than the climatic normal over most of the area. One area over the Philippine Sea and the South China Sea was 1 to 2 mb below normal. The second and most significant area was 5 mb less than normal, centered near 53°N, 165°E, midway between the Near Islands and the southern end of Kamchatka. The ocean east of about 170°W averaged higher than normal. The highest departure was a positive 6 mb, centered near 45°N, 145°W. This was slightly northeast of the center of the 1030-mb High, located at 40°N, 150°W. A 1006-mb Low was centered near 55°N, 170°E, where, according to climatology, only a trough is present.

An interesting feature on the Northern Hemisphere 30-day mean and departure from mean charts was a 990-mb Low, resulting in a minus 12-mb anomaly centered north of Bangladesh over Tibet. Any effects on the North Pacific weather were not immediately apparent.

The Pacific was very quiet and, other than tropical cyclones, the storms were weak, not attaining winds higher than gale strength, according to the plotted weather charts. The Pacific High produced more gale-force winds off the California coast than the LOWs did in any other specific area.

This first "storm" was one of the few that produced gale winds. Its beginning was on the 1st, near 43.4°N, 166.5°W, at 1010-mb. The circulation was very weak until 1200 on the 2d. By 0000 on the 3d, it had moved northeastward to 54°N, 145°W, in the Gulf of Alaska, with a pressure of 1002 mb. At that time, the gradient indicated that it could support winds of 35 kt or greater, but none were reported until 1200 on the 3d, although there were ships in the area. The USCGC CONFIDENCE measured 35-kt gales off Sitka, Alaska. By the 4th, the LOW had passed inland over Cape St. Elias.

On the 7th and early on the 8th, the Bering Sea was an area of general low pressure. Two small 1010-mb LOWS were analyzed north of the outer Aleutians. By 1800 on the 8th, these had combined to a 1008-mb LOW near 54.3°N, 170.5°W. The center crossed the Aleutians into the Gulf of Alaska about 0300 on the 9th. It drifted slowly eastward and, at 0000 on the 11th, was near 56°N, 152°W. The DAIAN MARU was hit by 45-kt gale winds as she passed about 60 mi south of the center. The central pressure was then about 1012 mb and filling. Early on the 12th, the LOW was absorbed into the larger scale circulation.

This LOW formed over land just east of the Tatar Strait on the 21st. It moved rapidly across the Kuril Islands and had a 997-mb center near 47°N, 151°E, at 0000 on the 22d. As it turned northeastward and moved toward the Bering Sea, the TAIO MARU was hit by 35-kt gales along the front, near 42°N, 153°E. At 1800 that day, the VAN TRIUMPH, southeast of the center near 48.2°N, 172.4°E, was scrubbed by moderate rain and 38-kt gales.

At 0000 on the 23d, the 978-mb LOW passed northeast of Attu Island, which suffered shifting 40-kt winds as the center moved northeastward. Several ships in the area reported 30-kt winds. The VAN TRIUMPH, sailing southwestward, was still measuring 38-kt winds. Later in the day, the ROBERT BANKS measured lashing 45-kt winds and 13-ft seas, almost on the Date Line at 50.8°N.

Twenty-four hours later, the STAR ACADIA was tossed by 40-kt gales, with 12-ft seas and swells, near 53°N, 170°W. The 975-mb LOW was located at 59°N, 173°W. The IDAHO STANDARD was just north of Unalaska Island at 0600, when she was whipped by 55-kt storm winds from the west. In the Gulf of Alaska, the PACIFIC ARROW found 35-kt gales at 1200 on the 24th, when the LOW moved inland near Hazen Bay, on the west coast of Alaska. Two shore stations, one on the Alaska Peninsula and the other on the Siberian coast, reported 35-kt winds. Ships in the Bering Sea were estimating 20- to 25-kt winds. The LOW turned northward and, as it crossed the Seward Peninsula, Uelen, on the Siberian side of the Bering Strait, reported chilling 40-kt winds, 36°F temperatures, and 100 percent relative humidity.

On the 26th, the LOW turned southeastward across the Alaskan Range. It was last identified near Valdez.

This LOW was exported from Nanking, China, at 1200 on the 27th. It moved across the Yellow Sea on the 28th and into the Sea of Japan on the 29th, with 1003-mb pressure. A significant amount of rain fell on northern Japan as the storm passed over on the 30th. The 16,079-ton FEDERAL NAGARA dragged her anchors and ran aground on muddy bottom in Inchon Harbor on the 29th.

It was not until September 1, when the storm had moved a considerable distance to sea, that gale-force winds developed. At 0000, the 996-mb LOW was at 45.5°N, 170°E, and the TATKAI MARU, at 45.9°N, 167.9°E, was headed northeast into 35-kt gales. Twenty-four hours later, the SEIHO MARU and the WEUI were blown by 35-kt winds in the southwest quadrant of the storm.

At 1200 on the 2d, the LOW reached its lowest pressure of 982 mb, near Atka Island in the Aleutians. The TATKAI MARU, which was following the LOW eastward, was hit by 40-kt winds on the 3d, and the PACIFIC PHOENIX had 35-kt gales 200 mi south of the center. She also contended with 15-ft swells.

As the LOW moved into the Gulf of Alaska, it was filling and no longer any concern to shipping. By the 6th, it had dissipated to a 1001-mb depression.

On the 9th, two tropical depressions more than 2,000 mi apart triggered Georgia and Hope. Both storms

developed in areas not known for prolonged life. Georgia formed in the South China Sea, just inside the Luzon Strait, and Hope began just east of the Volcano Islands, near 20°N, 145°E. In these northern latitudes, Hope was only able to reach tropical storm strength. She moved northwestward, and, by the 12th, was a weak depression near 32°N, 150°E. Meanwhile, Georgia was on a westward course, developing rapidly. On the 10th, she was a typhoon, bearing down on Hai-nan with 65-kt winds. Georgia became the first of four tropical cyclones to maul Hai-nan during August and September. She struck the northeast coast of the island and turned northward. On the 12th, the typhoon moved onto mainland China near Tien Pai.

While Georgia and Hope were fading, typhoon Iris was budding near 22°N, 130°E, on the 10th. She was quickly forced to tropical storm stage the same day, but then slowly matured while moving northward over the next 2 days. Iris blossomed into a typhoon on the 13th, about 150 mi south of Minamidaito Jima. Maximum winds reached 85 kt, with gusts to 125 kt. On the 14th, Iris turned northwestward toward the Ryukyu Islands. The LICA MAERSK was 160 mi south of Nagoya, at 32.2°N, 137.3°E, and reported 40-kt winds and thunderstorms during the past hour. The following day, she passed over Anamio Shima with minimum typhoon winds. The AMERICAN MAIL was west of Iris, headed northeastward on a converging track. At 0600 on the 15th, she was bucking 35-kt northerly winds, 6.5-ft seas, and 10-ft swells. Eighteen hours later, at 0000 on the 16th, the winds were 40 kt, seas 11.5 ft, and the swells 13 ft, when she was about 100 mi northwest of the eye. The storm passed to the south and then to the west. Iris continued to go to seed as she traversed the East China Sea. On the 16th, she dropped to tropical storm strength and turned northward toward Korea. The next day, moving along the west coast of South Korea, she began to turn extratropical.

At 1200 on the 17th, Iris was just north of Seoul, Korea. A cold front with a wave was to the north in Manchuria. By 0000 on the 18th, Iris had moved northeastward and drawn the front into its circulation, completing the transition to extratropical characteristics, just south of Vladivostok. She then moved rapidly across Hokkaido. The 602-ton HOKUYO MARU was capsized off southern Hokkaido late on the 18th. One crewman clung to a tire tube for 14 hr before being rescued. At 1200 on the 19th, the 998-mb LOW was at 44°N, 159°E. The GLOMAR CHALLENGER, near 41°N, 154.5°E, was treated to 35-kt winds. Twelve hours later, the SILVER ARROW, near 41°N, 163°E, about 430 mi southwest of the center, also had 35-kt gales.

The LOW was then pushing against the stationary Pacific High, which was centered near 45°N, 152°W. It was a losing battle, and Iris was suffering from old age.

Joan came to life in the Philippine Sea--an area noted for developing supertyphoons. However, this baby barely reached tropical storm strength before petering out in the East China Sea. She was first sighted on the 18th, near 20°N, 130°E. Heading westward, Joan became a tropical storm on the 19th. By the 20th, she was through the Luzon Strait and weakening to a depression. The CHEVRON HAWAII and the LOUISE LYKES were caught by some of the dying gasps, northeast of the storm. The CHEVRON HAWAII, reported 40-kt winds, with 10-ft seas and 12-ft swells. The LOUISE LYKES, further east, measured 38-kt winds and 15-ft seas.

Four days later, Kate came to life just southwest of Hai-nan. She crossed the island as a depression, on a northwestward heading. The following day, on the 25th, Kate intensified to tropical storm strength as she emerged into the Gulf of Tonkin. From here, she headed westward, moving into North Vietnam late on the 25th.

A tropical depression developed into tropical storm Heather at 1800 on the 31st, after a period of development starting on the 29th.

The convergence zone was active along 8°N, 82°W to 10°N, 92°W and, at 0000 on the 30th, a large cloud mass, on satellite pictures near 13°N, 94°W, indicated that a disturbance had formed. The AMERICAN LIBERTY and the UNDEN reported pressures of about 1007 mb, and a cyclonic circulation near 13°N, 93°W was indicated.

No further reports were received until 1800 on the 30th, when the disturbance became a depression with a central pressure of 1004 mb, centered near 13.4°N, 94°W. The AMERICAN AQUARIUS, CHRYSALEMA, and the DAISHIN MARU were in the peripheral area.

The depression developed into a tropical storm after moving northwest to 15°N, 95°W, at 1800 on the 31st. At 0000 that day, the BOSTON had reported 40-kt southwesterly winds at 13°N, 93°W. The TEXAN reported 30-kt winds about 30 mi southeast of the center, and, at 2100, found 54-kt winds, with 26-ft swells, at 15.4°N, 95.6°W.

At 1800 September 1, Heather was relocated near 15.5°N, 98°W, farther west than previous movement would have indicated. Reports from the CLARK-MAXWELL and the PEMEX C indicated a weak circulation. Three hours later, she was downgraded to a depression, and no further bulletins were issued.

Casualties--Several casualties occurred other than those mentioned in the text. Two Japanese freighters collided in fog on the 20th, off Cape Inubo. They were the 999-ton YUHO MARU and the 534-ton TOMOHIRO MARU. There were no injuries. Inchon, Korea, was a bad harbor to be in on the 29th. Heavy weather contributed to the grounding of the 10,542-ton Greek-registered ASHBURN and the 3,831-ton Korean-registered SEOUL. Both dragged their anchors.

Three casualties occurred in the Indian Ocean. The NEPTUNE SAPPHIRE (12,000 tons), on her maiden voyage, broke in two in heavy seas 120 mi southeast of Durban. The 5,568-ton Singapore motorship PREMIER ARCTIC went aground on a reef in the Red Sea, during a sandstorm. The Liberian tanker FIDELITY (12,107 tons) buckled a forward plate in high seas off the Horn of Africa. On the 9th, the Greek TEMBO (3,188 tons) went aground at 1.7°S, 41.5°E, as a result of steering damage due to rough seas. The drilling platform C.E. THORNTON (1,466 tons) broke tow in a storm and went aground at 18.9°N, 57.5°E. On the 26th, the Norwegian SYDNESS (802 tons) sank in a storm at 9°N, 52.5°E. One crew member died, and the remainder was picked up from lifeboats by the MERCURY LAKE.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

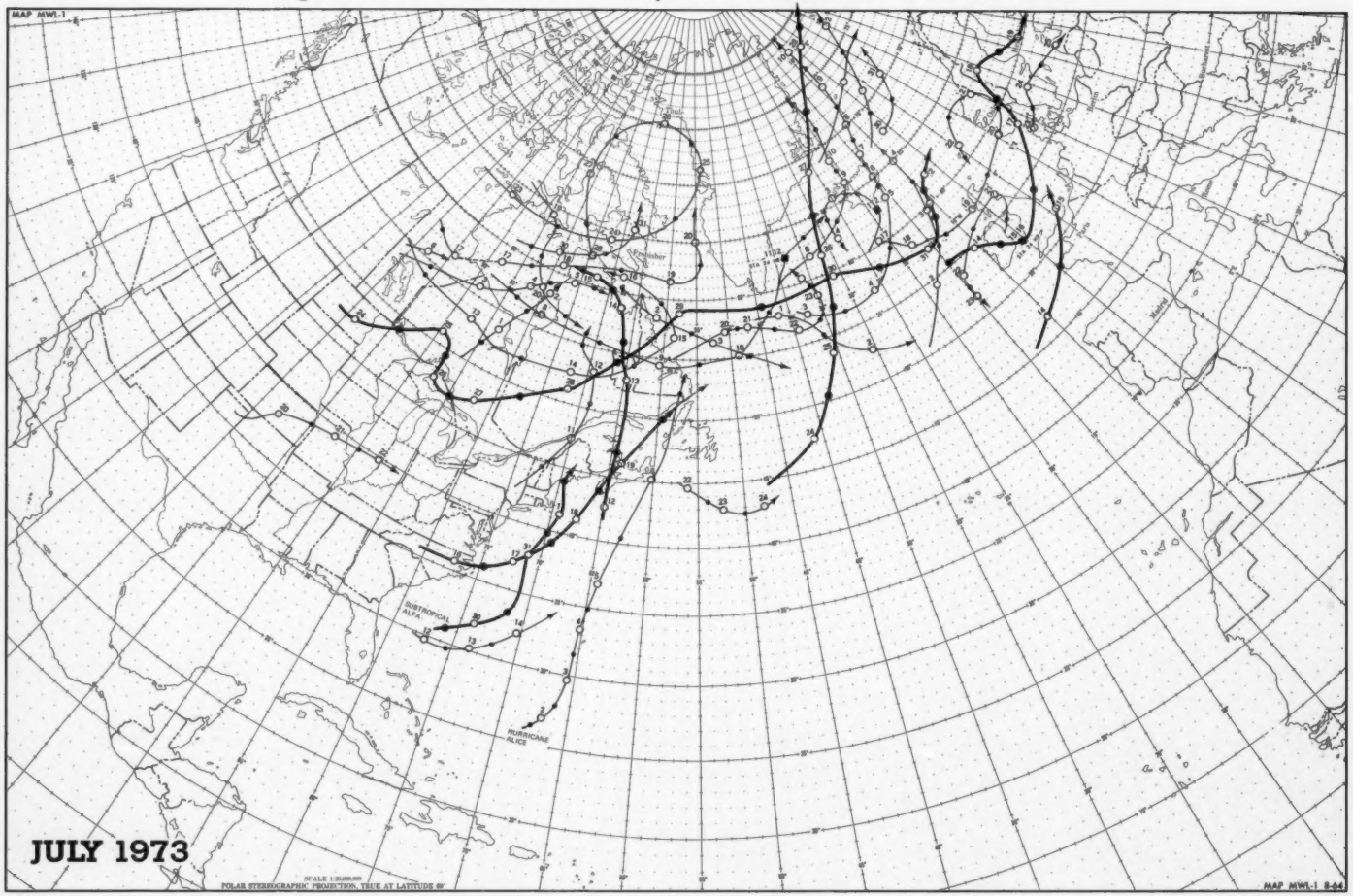


Figure 36.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Atlantic

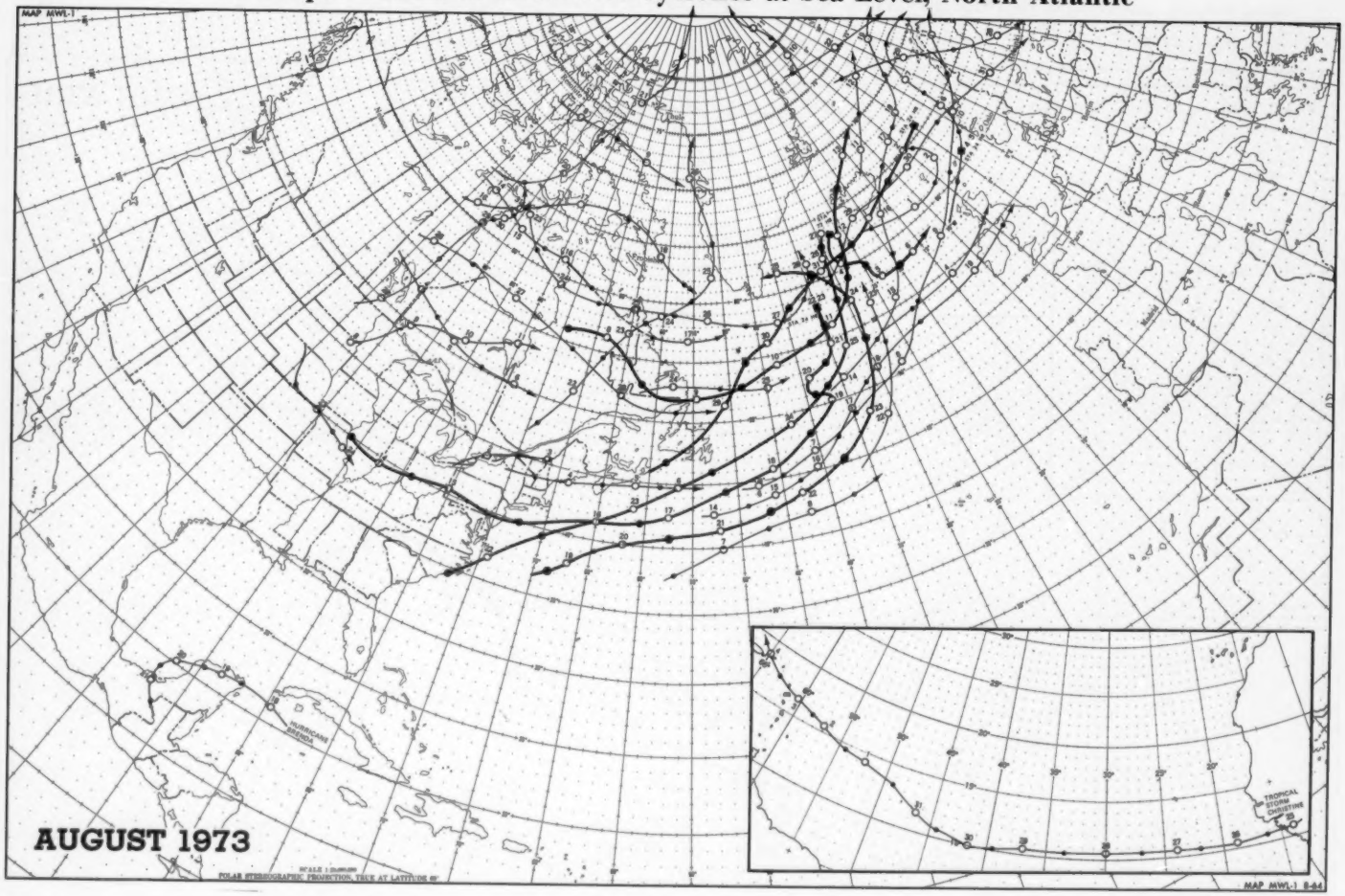


Figure 37.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

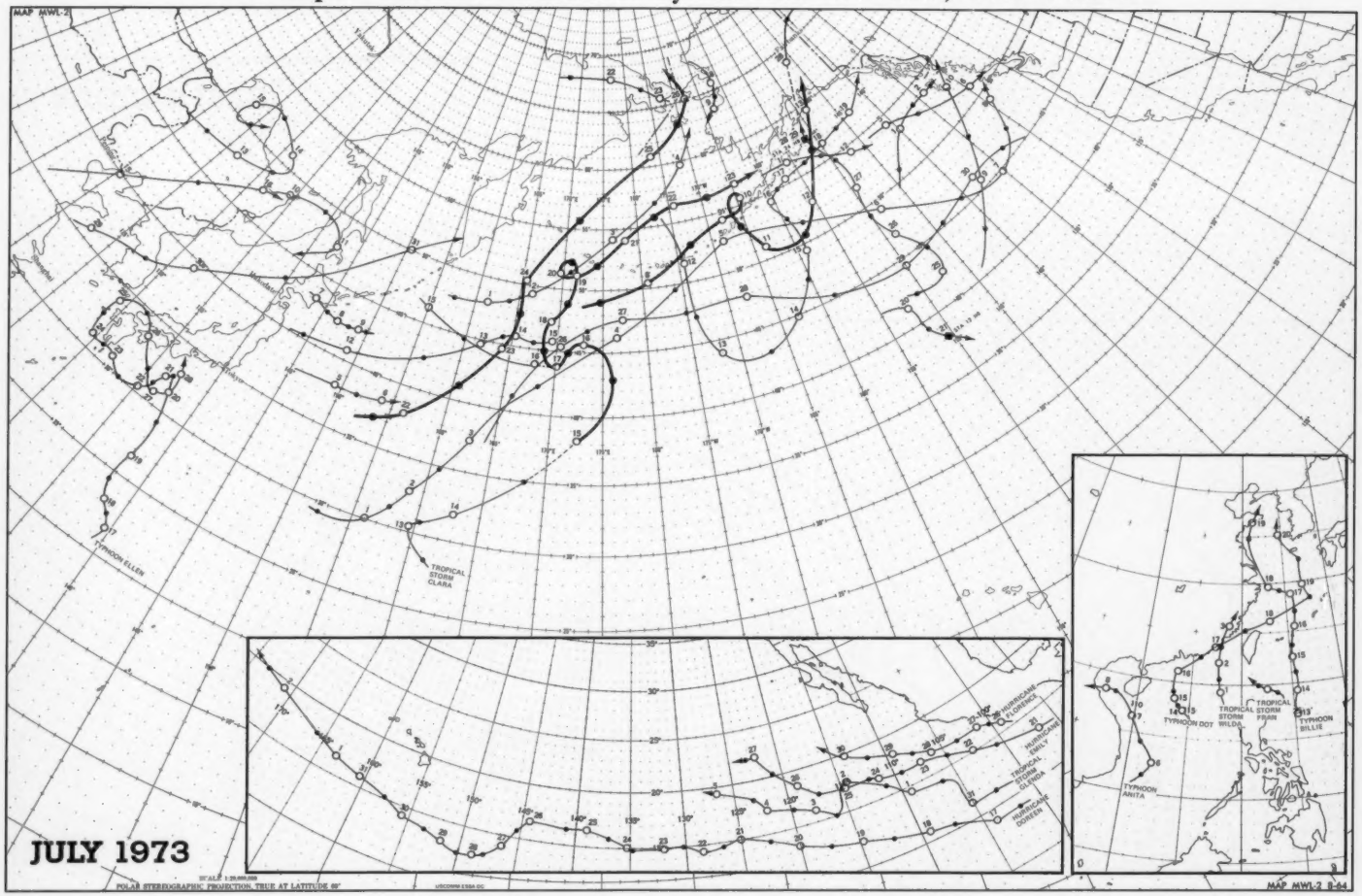


Figure 38.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

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Principal Tracks of Centers of Cyclones at Sea Level, North Pacific

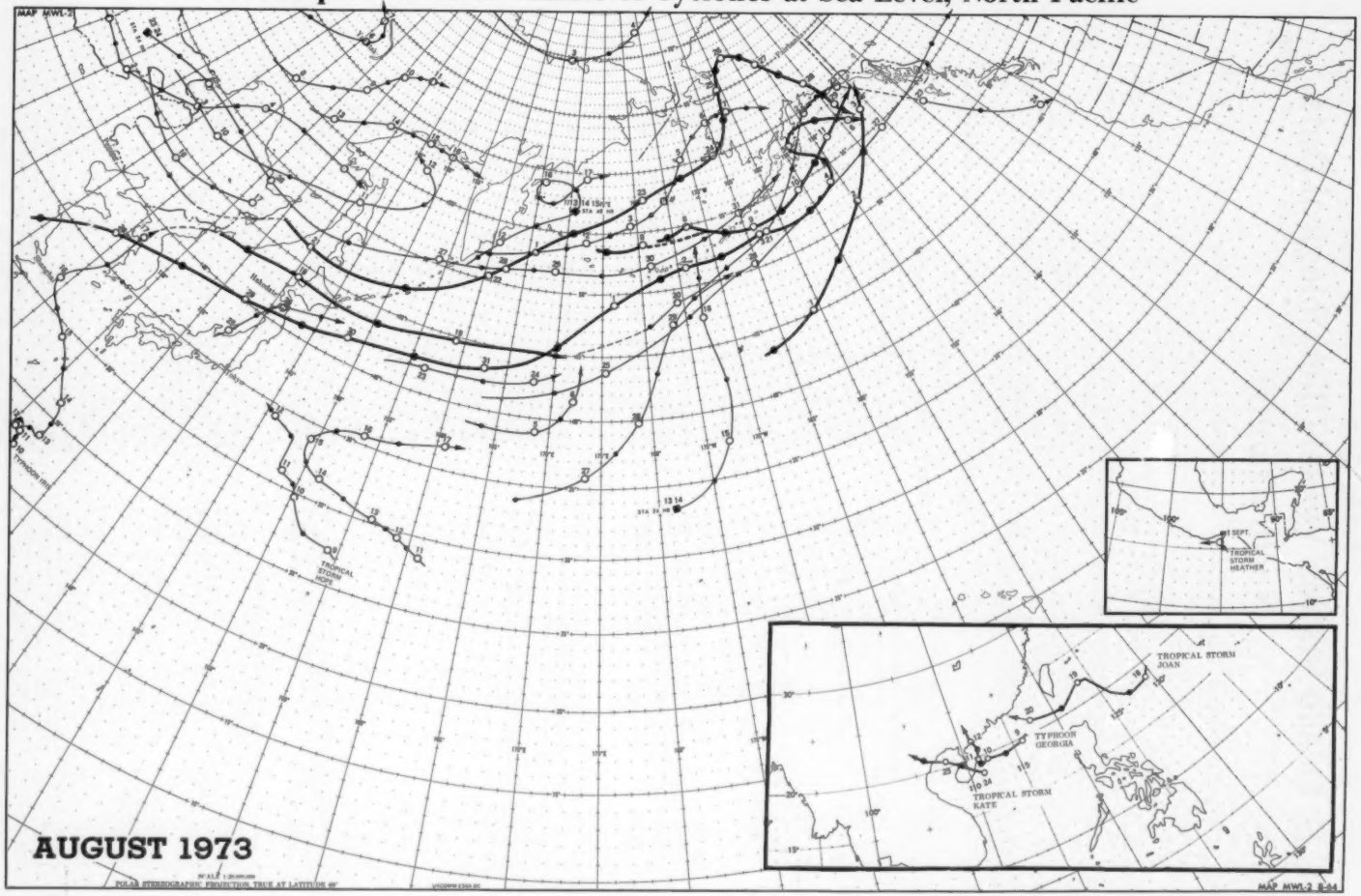

Figure 39.--Open circle indicates 1200 GMT position and closed circle 0000 GMT position. Square indicates stationary center. Cyclone tracks marked with a heavy line are described in the Smooth Log.

Table 5
U.S. Ocean Station Vessel Climatological Data, North Atlantic

Ocean Weather Station 'BRAVO' 56°30'N 51°00'W — **July and August, 1973**

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C)					DEW-POINT TEMP (°C)					SEA TEMP (°C)					AIR-SEA TEMP DIFFERENCE (°C)				
	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR	MIN	DA HR	MEAN	MAX	DA HR
JULY	4.8	12 03	8.4	13.4	31 19	2.0	27 12	6.9	10.8	29 18	5.9	01 21	8.2	13.3	31 18	- 3.2	27 03	.2	5.6	12 18
AUG	6.8	07 09	9.4	11.8	23 09	2.1	04 00	6.9	10.4	16 21	6.7	17 18	10.5	12.2	04 03	- 4.5	04 03	- 1.1	3.1	17 18

MONTH	MEANS AND EXTREMES — PRESSURE (MB)					PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) — TOTAL CLOUD				LOW CLOUD				DAYS WITH SPECIFIED WEATHER — RAIN OR DREL	SNOW	TSTM	VERY WIND <12N **	≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
	MIN	DA HR	MEAN	MAX	DA HR	0-2	3-5	6-7	8 & OBSC	0-2	3-5	6-7	8 & OBSC	PCPN									
JULY	980.8	07 15	1008.0	1019.7	*25 08	8.4	13.9	17.3	80.4	28.2	8.9	19.3	44.5	18	18	0	0	15	2	0	0	29	19.8	202
AUG	994.6	26 03	1011.4	1020.9	*02 15	6.7	10.9	23.6	58.7	19.7	19.1	28.1	99.1	15	15	0	0	3	1	0	0	26	11.8	238

** VV-90-93 AND/OR W=4 COMP OB DAYS-COMPLETE OB DAYS

Wind

JULY — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.8	4.8	.0	.0	.0	5.0	15.1
NE	.1	1.0	2.7	.0	.0	.0	3.8	13.2
E	.4	3.3	4.1	.0	.0	.0	7.8	11.0
SE	.3	4.0	7.2	2.5	.0	.0	14.1	14.2
S	.0	8.4	7.7	2.0	.0	.0	18.1	12.0
SW	.0	10.9	10.1	1.8	1.0	.0	23.8	12.7
W	.4	4.6	6.3	1.4	.0	.0	12.7	13.1
NW	.0	3.5	5.4	3.8	.0	.0	12.4	16.7
CALM	2.3	.0	.0	.0	.0	.0	2.3	.0
TOTAL	4.0	36.1	48.0	10.9	1.0	.0	100.0	13.1

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
202	210	38	07 2200	4.0	220	

AUG — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.3	5.8	6.9	2.3	.0	.0	15.3	13.6
NE	.0	3.8	4.8	1.1	.0	.0	9.7	12.6
E	.3	2.7	.0	.0	.0	.0	3.0	6.0
SE	.1	2.9	2.3	.0	.0	.0	5.4	9.8
S	.0	2.0	6.3	.8	.0	.0	9.3	14.5
SW	.0	6.9	3.4	.8	.0	.0	11.1	10.6
W	.3	9.6	11.0	.0	.0	.0	20.9	10.9
NW	1.1	7.0	12.0	2.8	1.3	.0	23.8	14.8
CALM	3.4	.0	.0	.0	.0	.0	3.4	.0
TOTAL	5.9	40.8	45.8	7.9	1.3	.0	100.0	12.2

NUMBER OF OBS	MAX WIND DIR	SPEED	DA HR	VECTOR SPEED	MEAN DIR	(DIR IN DEGREES)
238	310	40	30 0900	5.1	305	

Wave

JULY — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	4.3	2.8	.0	.0	.0	.0	.0	7.1
NE	.0	4.1	1.5	.0	.0	.0	.0	.0	5.6
E	.0	4.3	.9	.0	.0	.0	.0	.0	5.2
SE	.0	7.7	3.5	1.0	.0	.0	.0	.0	12.1
S	.0	18.8	3.5	.0	.0	.0	.0	.0	22.3
SW	.5	11.1	.9	1.1	2.0	.0	.0	.0	15.6
W	.0	3.0	2.2	1.4	.5	.0	.0	.0	7.1
NW	.5	8.4	6.3	.0	.0	.0	.0	.0	15.2
IND	.0	9.9	.0	.0	.0	.0	.0	.0	9.9
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.0	71.8	21.3	3.5	2.5	.0	.0	.0	100.0

NUMBER OF OBS 202 — IND=INDETERMINATE

AUG — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.6	10.8	3.5	.8	.0	.0	.0	.0	15.8
NE	.0	7.2	5.4	1.7	.0	.0	.0	.0	14.3
E	.0	3.5	.4	.0	.0	.0	.0	.0	3.9
SE	.0	3.0	.0	.0	.0	.0	.0	.0	3.0
S	.0	6.2	.8	.0	.0	.0	.0	.0	7.0
SW	.0	5.1	1.3	.0	.0	.0	.0	.0	6.9
W	.0	13.3	.9	.0	.0	.0	.0	.0	14.3
NW	.2	11.2	4.0	2.9	1.3	.0	.0	.0	19.6
IND	.0	13.9	1.3	.0	.0	.0	.0	.0	15.1
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	.8	74.4	18.1	5.5	1.3	.0	.0	.0	100.0

NUMBER OF OBS 238 — IND=INDETERMINATE

JULY — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	1.0	33.1	3.0	.0	.0	.0	.0	.0	41.1
6-7	.0	28.2	10.3	2.0	1.5	.0	.0	.0	44.0
8-9	.0	.3	.0	1.5	1.0	.0	.0	.0	2.8
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	9.9	.0	.0	.0	.0	.0	.0	9.9
TOTAL	1.0	71.8	21.3	3.5	2.5	.0	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR	IND=INDETERMINATE
202	4.5	9	220	SEa	08 00	(DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

AUG — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-3.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	.0	39.9	5.5	2.1	.0	.0	.0	.0	47.5
6-7	.8	17.2	9.2	.8	1.3	.0	.0	.0	29.4
8-9	.0	2.9	.8	1.7	.0	.0	.0	.0	5.5
10-11	.0	.0	1.3	.8	.0	.0	.0	.0	2.1
12-13	.0	.4	.0	.0	.0	.0	.0	.0	.4
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	13.9	1.3	.0	.0	.0	.0	.0	15.1
TOTAL	.8	74.4	18.1	5.5	1.3	.0	.0	.0	100.0

NUMBER OF OBS	MAX WAVE HEIGHT HGT	PER	DIR	TYPE	DA HR	IND=INDETERMINATE
238	4.0	7	330	SEa	30 12	(DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 6
CLIMATOLOGICAL DATA

Ocean Weather Station 'CHARLIE' 52°45'N 35°30'W — July and August, 1973

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
JULY	7.2	01 00	11.4	15.2	22 15	1.4	06 03	9.8	14.8	25 09	7.8	*06 06	11.4	15.4	*25 18	- 3.7	23 09	.6	3.2	25 09
AUG	9.1	06 00	11.7	15.5	30 09	3.3	19 06	9.2	14.5	30 09	9.4	09 15	11.6	14.6	*17 03	- 3.7	04 00	.1	3.6	30 09

MEANS AND EXTREMES — PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS) — DAYS WITH SPECIFIED WEATHER

MONTH	PRESSURE (MB) MIN	DA HR	MEAN	MAX	DA HR	TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC	RAIN OR DRZL	SNOW	TSTM	VSBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	SOBS WITH PCPN	NO OF OBS
JULY	996.1	25 09	1017.8	1029.2	*16 15	2.8	1.1	11.3	84.7	7.9	1.7	9.0	81.4	14	19	0	0	13	2	0	0	18	18.6	177
AUG	988.6	21 06	1009.4	1024.0	03 00	.4	9.0	24.5	66.1	12.7	15.1	24.5	47.8	20	20	0	0	7	7	0	0	29	19.9	245

** VV-90-93 AND/OR W=4 COMP OB DAYS-COMPLETE OB DAYS

Wind

JULY — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	2.0	2.7	.0	.0	.0	4.7	12.0
NE	.0	.8	.4	.0	.0	.0	1.0	11.1
E	.0	1.0	2.7	.6	.0	.0	4.2	14.9
SE	.0	.7	.0	.0	.0	.0	1.3	13.8
S	.0	2.5	5.6	4.7	1.1	.0	14.0	19.4
SW	.7	8.9	11.2	17.1	.6	.0	38.4	19.6
W	1.0	8.9	12.7	3.7	.0	.0	26.3	14.4
NW	.0	3.7	5.9	.6	.0	.0	10.2	13.6
CALM	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	1.7	28.2	41.2	27.1	1.7	.0	100.0	16.8

NUMBER OF OBS 177 — MAX WIND DIR 210, SPEED 39, DA HR 29 1455 — VECTOR SPEED 11.8 — MEAN DIR 234 — (DIR IN DEGREES)

AUG — WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.4	2.0	3.7	1.2	.0	.0	7.3	14.7
NE	.0	.9	4.3	3.4	.8	.0	8.4	20.4
E	.0	.4	5.4	1.9	.0	.0	7.8	16.2
SE	.0	.8	.9	.0	.0	.0	1.7	11.6
S	.0	.3	4.0	4.2	1.4	.0	9.9	24.9
SW	.0	1.8	9.9	5.3	.2	.0	17.2	19.0
W	.0	5.5	19.4	7.6	2.9	.0	35.8	19.7
NW	.4	2.1	7.2	3.0	1.6	.0	14.4	20.0
CALM	.4	.0	.0	.0	.0	.0	.4	.0
TOTAL	1.2	13.1	51.0	28.6	6.1	.0	100.0	19.2

NUMBER OF OBS 245 — MAX WIND DIR 310, SPEED 46, DA HR 06 0400 — VECTOR SPEED 8.2 — MEAN DIR 244 — (DIR IN DEGREES)

Wave

JULY — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	4.9	1.3	.0	.0	.0	.0	.0	6.2
NE	.0	.7	.4	.0	.0	.0	.0	.0	1.1
E	.6	2.7	.0	.0	.0	.0	.0	.0	3.2
SE	.6	.1	.0	.0	.0	.0	.0	.0	.7
S	1.6	7.8	.8	2.0	.8	.0	.0	.0	12.1
SW	4.7	12.6	12.4	7.5	2.3	.0	.0	.0	39.4
W	1.7	13.6	7.3	1.8	.0	.0	.0	.0	24.7
NW	.6	7.6	3.7	.0	.0	.0	.0	.0	11.9
IND	.0	.0	.0	.0	.0	.0	.0	.0	.6
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	9.6	50.8	26.0	11.3	3.2	.0	.0	.0	100.0

NUMBER OF OBS 177 — IND=INDETERMINATE

AUG — WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.7	3.2	1.8	1.1	.0	.0	.0	.0	6.9
NE	.0	.2	2.2	.5	.5	.0	.0	.0	3.5
E	.0	1.3	2.6	6.7	.7	.0	.0	.2	11.5
SE	.0	.8	.7	.2	.0	.0	.0	.0	1.7
S	.0	.0	1.9	3.1	2.3	.0	.0	.0	7.3
SW	.0	5.3	3.4	8.8	.1	.0	.0	.0	19.6
W	.4	10.5	3.9	9.2	2.9	.0	.0	.0	26.9
NW	.9	6.9	3.1	2.2	1.6	.0	.0	.0	14.8
IND	.0	.0	1.2	3.3	.0	.0	.0	.0	4.5
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	2.0	27.8	26.9	35.1	8.2	.0	.0	.0	100.0

NUMBER OF OBS 245 — IND=INDETERMINATE

JULY — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	9.6	33.3	11.9	.0	.0	.0	.0	.0	54.8
6-7	.0	10.4	14.1	10.2	2.3	.0	.0	.0	42.9
8-9	.0	.0	.0	1.1	.0	.0	.0	.0	1.7
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.6
TOTAL	9.6	50.8	26.0	11.3	2.3	.0	.0	.0	100.0

NUMBER OF OBS 177 — MAX WAVE HEIGHT: HGT 4.5, PER 7, DIR 210, TYPE SEA, DA HR 30 00 — IND=INDETERMINATE (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

AUG — WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	2.0	15.1	2.4	.0	.0	.0	.0	.0	19.6
6-7	.0	10.6	22.4	16.7	3.3	.0	.0	.0	53.1
8-9	.0	2.0	.8	15.1	4.9	.0	.0	.0	22.9
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	1.2	3.3	.0	.0	.0	.0	4.5
TOTAL	2.0	27.8	26.9	35.1	8.2	.0	.0	.0	100.0

NUMBER OF OBS 245 — MAX WAVE HEIGHT: HGT 9.0, PER 8, DIR 290, TYPE SEA, DA HR 31 12 — IND=INDETERMINATE (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 7
Selected Gale Observations, North Atlantic

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec	Sea Waves* Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH ATLANTIC		JULY															
SS TILLIE LYKES	AMERICAN	4	31.5 N	64.6 W	15	23	35 (A)	5 NM	15	1012.8	27.2	25.6	4	5	20	7	10
SS MARSHFIELD	AMERICAN	5	36.2 N	68.3 W	00	09	36 (A)	5 NM	02	1000.5	24.5	27.7	5	8	09	7	13
SS AMER LEGEND	AMERICAN	5	37.0 N	62.5 W	18	23	30 (A)	5 NM	02		23.3	24.4					
SS STAGHOUND	AMERICAN	6	39.5 N	55.5 W	06	18	35 (A)	5 NM	03	1022.0	23.3	23.6	3	5	21	6	10
SS AMER LEGEND	AMERICAN	6	38.0 N	57.7 W	06	23	35 (A)	5 NM	03	1020.7	22.2	23.5	4	6.5	23	< 6	13
SS AMER ACCORD	AMERICAN	6	39.5 N	56.9 W	18	20	40 (A)	5 NM	02	1025.0	23.9	20.0	6	10	21	10	11.5
SS ESSO FLORENCE	AMERICAN	7	27.6 N	68.9 W	00	20	35	10 NM	25	1019.6	24.0	27.8	7	6.5			
SS THOMAS M	AMERICAN	9	36.3 N	08.2 W	00	33	35	10 NM	01	1016.9	19.0	20.0					
MV VOLNAY	BRITISH	10	42.4 N	44.4 W	00	21	35	5 NM	03	1018.0	21.0						
MV VOLNAY	BRITISH	12	40.8 N	02.4 W	00	24	35	10 NM	60	1012.0	25.0						
SS EMPIRE STATE	AMERICAN	12	40.6 N	58.7 W	18	19	M 40	.5 NM	61	1008.9	22.2	23.9	8	18			
SS EMPIRE STATE	AMERICAN	13	40.7 N	59.6 W	00	22	M 37	2 NM	80	1006.2	24.8	25.3	10	18			
MV NORGH MERCHANT	NORWEGIAN	13	46.9 N	18.7 W	18	33	35	10 NM	02	1014.0	16.0	18.0					
SS STAGHOUND	AMERICAN	13	49.2 N	18.3 W	12	28	40	5 NM	15	1010.3	12.3	14.0	7	16.5			
SS AMER ARCHER	AMERICAN	16	49.7 N	15.2 W	12	36	40	1 NM	12	1009.0	15.0	16.7	3	10			
MV ATLANTIC FOREST	NORWEGIAN	16	47.4 N	13.7 W	06	32	M 46	5 NM	25	1007.0	16.7	21.0					
SS SEATRAIN OHIO	AMERICAN	17	49.3 N	13.7 W	12	34	40	5 NM	02	1014.2	15.8	16.3	10	10			
SS SEATRAIN OHIO	AMERICAN	18	48.3 N	20.9 W	06	29	35	5 NM	10	1024.7	15.0	14.4	8	6.5			
SS SEATRAIN OHIO	AMERICAN	19	46.9 N	28.6 W	06	27	35	5 NM	02	1025.4	14.5	18.5	8	6.5			
SS TILLIE LYKES	AMERICAN	19	49.1 N	08.3 W	18	27	M 37	5 NM	15	1009.5	16.7	17.8	5	6.5			
SS TILLIE LYKES	AMERICAN	20	48.2 N	13.5 W	06	31	M 33	5 NM	18	1009.1	14.4	15.0	3	5			
SS SEATRAIN OHIO	AMERICAN	22	37.0 N	51.1 W	12	20	40	10 NM	02	1026.1	24.3	25.0					
SS SEATRAIN OHIO	AMERICAN	23	34.5 N	53.3 W	00	20	35	10 NM	02	1027.1	23.8	25.0					
SS AMER RANGER	AMERICAN	23	39.8 N	30.5 W	18	22	35	5 NM	03	1019.3	26.8	24.5	2	1.5	22	>13	10
MV TRAVIATA	SWEDISH	24	42.7 N	44.1 W	12	22	45	5 NM	02	1014.0	26.0	25.0					
SS TILLIE LYKES	AMERICAN	24	39.5 N	53.2 W	06	21	40	5 NM	02	1006.4	23.9	25.0	4	6.5	21	6	13
SS AMER RANGER	AMERICAN	24	41.0 N	45.5 W	06	22	35	10 NM	01	1018.6	23.5	21.0	9	6.5	22	>13	13
SS LOS ANGELES	AMERICAN	24	41.6 N	48.9 W	12	18	40	1 NM	53	1004.5	19.5	24.5	3	8			
MV TRAVIATA	SWEDISH	25	42.0 N	48.3 W	00	32	35	10 NM	02	1014.6	20.0	23.0					
SS NEW YORKER	AMERICAN	29	34.7 N	73.1 W	06	16	40	5 NM	60	1014.9	28.0	30.0					
OCEAN STATION VESSELS																	
ATLANTIC B																	
USCGC DALLAS	AMERICAN	8	56.4 N	50.8 W	00	22	N 35	5 NM	02	991.6	7.2	6.7	9	14.5	26	10	13
ATLANTIC C																	
USCGC HAMILTON	AMERICAN	25	31.4 N	37.6 W	09	18	35	.5 NM	46	996.1	14.8	11.6	4	5			
USCGC MORGENTHAU	AMERICAN	29	52.8 N	35.5 W	15	21	N 39	1 NM	61	1020.4	12.9	11.0	6	11.5			
GREAT LAKES VESSELS																	
SS ARTHUR M ANDERSON	AMERICAN	12	47.2 N	90.7 W	06	36	M 38	10 NM	18		11.0	6.0	4	3			
SS LEON FALK JR	AMERICAN	14	47.5 N	87.7 W	00	29	M 35	10 NM	03		16.0	4.0	5	5			
NORTH ATLANTIC		AUG.															
SS MARSHFIELD	AMERICAN	2	34.4 N	74.4 W	18	21	35	5 NM	01	1011.5	26.3	28.8	5	6.5	21	X	14.5
SS GULFCREST	AMERICAN	2	48.1 N	61.6 W	12	18	35	5 NM	02	1012.5	20.0	20.0	3	8			
SS MARSHFIELD	AMERICAN	3	34.0 N	73.4 W	00	21	35	5 NM	02	1011.2	26.7	30.0		8	21	X	11.5
SS PIONEER COMMANDER	AMERICAN	4	55.4 N	25.5 W	18	29	40	10 NM	01	1000.3	10.6	17.5	6	16.5			
SS KEVA IDEAL	AMERICAN	4	27.9 N	91.2 W	18	16	45	5 NM	15	1008.9	26.1	29.4	10	13			
SS TOLUCA	MEXICAN	4	52.4 N	22.9 W	06	24	M 40	5 NM	02	999.0	18.0	13.0	8	10			
SS PIONEER COMMANDER	AMERICAN	5	54.0 N	28.4 W	00	28	42	10 NM	02	1000.7	9.5	13.0	6	16.5			
MV KAREN MAERSK	DANISH	5	42.5 N	40.3 W	12	24	38	5 NM	07	1018.4	25.0	23.0	5	6.5			
MV KAREN MAERSK	DANISH	6	42.6 N	44.0 W	00	27	40	10 NM	00	1017.0	23.0	24.0	5	6.5			
SS ANCHORAGE	AMERICAN	8	48.2 N	11.4 W	00	22	35	1 NM	53	999.2	17.2	18.4	5	11.5			
SS RIO HANAMO	LIBERIAN	9	56.4 N	16.5 W	06	05	35	2 NM	63	991.2	11.2	13.8	3	6.5	36	6	6.5
SS RIO HANAMO	LIBERIAN	10	56.6 N	28.8 W	12	22	35	2 NM	63	1001.4	11.2	11.1	3	8			
MV H P GRACE	LIBERIAN	10	49.1 N	40.7 W	00	19	38	10 NM	80	1009.0	18.4	18.4	6	8			
SS AMER RANGER	AMERICAN	10	51.3 N	33.0 W	12	20	40	5 NM	65	1005.8	15.6	10.6	6	8	20	12	13
SS AMER ACCORD	AMERICAN	10	48.7 N	35.2 W	12	20	35	5 NM	02	1011.2	15.6	15.6	8	10			
MV NOPAL LUNA	NORWEGIAN	12	24.3 N	83.0 W	12	11	48	< 50 YD	82	1020.0	27.1	30.0					
SS STAGHOUND	AMERICAN	14	42.5 N	30.6 W	12	18	40	5 NM	07	1006.4	18.8	18.7	5	10			
SS OCEANIC	PANAMANIAN	15	39.8 N	73.7 W	06	02	M 38	2 NM	01	1002.5	17.8	24.4	4	8	09	6	8
MV CORANTIJN	NETHERLANDS	16	17.8 N	73.5 W	06	13	40	5 NM	16	1012.2	27.7	28.6	7	6.5			
USCGC INGHAM	AMERICAN	16	50.6 N	39.4 W	12	07	M 35	5 NM	02	1017.9	12.5	14.6	7	14.5			
SS MARSHFIELD	AMERICAN	16	44.8 N	44.8 W	00	34	40	5 NM	07	1009.0	17.2	24.4		8	34	X	16.5
SS SACREMENTO	AMERICAN	18	21.5 N	64.6 W	12	11	50 (D)	.25 NM	65	1008.8	25.6	30.0	9	19.5			
MV HOSENGEN	NORWEGIAN	19	39.7 N	62.6 W	18	12	M 39	2 NM	64	1014.3	22.8	23.0		6.5	13	X	13
SS SEATRAIN MAINE	AMERICAN	19	20.2 N	84.1 W	00	14	38 (D)	10 NM	05	1011.2	27.8	29.4	6	8			
SS KEYTANKER	AMERICAN	20	36.5 N	73.5 W	00	04	40	10 NM	00	1014.1	25.6	28.3					
MV EDE SOTTORF	GERMAN	21	30.1 N	59.4 W	12	27	40	10 NM	03	1005.1	24.0		8	14.5			
SS AMER ACCORD	AMERICAN	21	49.7 N	32.6 W	18	28	40	10 NM	02	1013.2	13.6	15.6	7	14.5			
SS LOS ANGELES	AMERICAN	21	38.7 N	60.5 W	06	24	39	5 NM	02	1002.3	26.7	28.7	8	10			
SS NEWARK	AMERICAN	21	40.5 N	33.3 W	22	21	36	5 NM	02	998.8	23.0	23.6	9	19.5			
SS AMER ACCORD	AMERICAN	22	49.2 N	35.0 W	00	23	38	10 NM	01	1017.8	14.4	15.0	7	14.5			
MV NOPAL LUNA	NORWEGIAN	23	20.9 N	19.2 W	06	03	40	10 NM	02	1014.5	21.5	22.0					
MV FALSTRIA	DANISH	24	43.6 N	35.8 W	18	20	35	5 NM	81	1011.0	20.6		5	10	20	9	19.5
SS AMER ACCORD	AMERICAN	24	44.7 N	31.2 W	00	19	38	10 NM	01	1009.0	14.4	15.0					
MV CORANTIJN	NETHERLANDS	25	14.0 N	64.3 W	06	07	37	50 YD	65	1013.2	25.0	27.8	7	10			
SS ATLANTIC ENTERPRISE	AMERICAN	26	18.8 N	67.8 W	22	04	35	2 NM	65	1014.2	25.8	30.0	8	10			
SS WALTER RICE	AMERICAN	29	16.5 N	82.1 W	21	10	28	5 NM	82	1011.0	27.8	28.7	6	6.5			
MV ATLANTIC FOREST	NORWEGIAN	29	38.6 N	59.3 W	18	33	M 35	10 NM	02	1009.5	26.7	29.0	8	10			
MV IRISH STAR	IRISH	30	33.3 N	34.9 W	03	30	32	.25 NM	82	1013.5	21.0						
SS AMER ALLIANCE	AMERICAN	30	50.6 N	44.3 W	12	27	40	10 NM	02	1004.0	11.2	10.2	5	8			

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind		Visibility	Present Weather code	Pressure mb	Temperature °C		Sea Waves*			Swell Waves		
			Lat. deg.	Long. deg.		Dir. 10's	Speed kt				Air	Sea	Period sec	Height ft	Dir. 10's	Period sec	Height ft
NORTH ATLANTIC		AUG.																
OCEAN STATION VESSELS																		
ATLANTIC B																		
USCGC MENDOTA	AMERICAN	30	55.0 N	50.9 W	09	31	M 48	2 NM	21	999.0	9.2	9.0	5	11.5				
ATLANTIC C																		
USCGC MORGENTHAU	AMERICAN	6	52.2 N	34.9 W	03	29	M 49	5 NM	02	1008.0	10.1	12.8	8	14.5				
USCGC MORGENTHAU	AMERICAN	10	52.6 N	35.3 W	09	17	M 41	1 NM	61	1000.0	12.4	10.8	7	13				
USCGC INGHAM	AMERICAN	30	52.7 N	35.2 W	09	20	M 45	2 NM	21	997.9	15.3	11.9	7	11.5				
USCGC INGHAM	AMERICAN	31	52.0 N	35.2 W	00	28	M 36	10 NM	03	1004.7	13.0	12.3	6	8	22	7	10
GREAT LAKES VESSELS																		
SS J L MAUTHE	AMERICAN	20	47.0 N	83.7 W	06	30	M 38	5 NM	02		17.0	16.0						
SS JOHN DYKSTRA	AMERICAN	20	45.4 N	83.4 W	18	30	M 37	10 NM	02		18.0	20.0						
SS LEON FALK JR	AMERICAN	21	44.5 N	82.9 W	00	33	M 36	> 25 NM	01		20.0	22.0	6	6.5				
SS JOHN SHERWIN	AMERICAN	21	46.5 N	85.2 W	00	33	M 45	> 25 NM	02		17.0	17.0	10	8				
SS LEON FRASER	AMERICAN	30	43.3 N	86.9 W	18	19	M 37	5 NM	18		23.0	24.0	6	6.5				

* Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind
(A) Hurricane Ava
(B) Tropical storm Bernice

NOTE: These observations are selected from those with winds of 35 kt or higher. In cases where a ship reported more than one observation a day with such winds, the observation with the highest wind speed was selected. In cases where two or more observations had the same wind speed, the one at 1200 GMT or the one closest to 1200 GMT was chosen. If this method still did not break a tie, the one with the lowest barometric pressure was picked. The data for the Ocean Station Vessels are based on 3-hr observations. In a good many cases, the maximum wind speeds given in the U. S. Ocean Station Climatological Data tables are higher because these are based on the Summary of Day entries.

Table 8
U.S. Ocean Station Vessel Climatological Data, North Pacific

Ocean Weather Station 'NOVEMBER' 30°00'N 140°00'W July and August, 1973

MEANS AND EXTREMES

MONTH	DRY BULB TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	DEW-POINT TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	SEA TEMP (°C) MIN	DA HR	MEAN	MAX	DA HR	AIR-SEA TEMP DIFFERENCE (°C) MIN	DA HR	MEAN	MAX	DA HR
JULY	19.0	08 06	21.3	24.0	19 18	9.4	23 12	16.2	19.1	22 00	20.5	17 06	21.8	23.8	21 00	- 2.3	30 12	- .5	2.5	04 00
AUG	19.5	18 12	21.6	23.9	10 00	14.0	16 18	17.4	19.4	29 00	20.6	21 06	22.3	23.3	11 00	- 2.8	19 12	- .8	1.1	06 00

MEANS AND EXTREMES — PRESSURE (MB)

MONTH	MIN	DA HR	MEAN	MAX	DA HR
JULY	1018.7	16 12	1022.8	1028.0	11 18
AUG	1017.3	08 00	1023.2	1030.3	24 18

PERCENTAGE FREQUENCY OF CLOUD AMOUNT (OKTAS)

MONTH	TOTAL CLOUD 0-2	3-5	6-7	8 & OBSC	LOW CLOUD 0-2	3-5	6-7	8 & OBSC
JULY	5.7	9.0	34.9	50.3	7.4	9.0	53.3	30.3
AUG	10.1	24.2	32.3	27.4	29.0	34.7	16.9	23.4

DAYS WITH SPECIFIED WEATHER

MONTH	RAIN OR DREL	SNOW	TSTM	VRBY <1KM **	WIND (KTS) ≥34	≥48	≥64	COMP OB DAYS	%OBS WITH PCPN	NO OF OBS
JULY	10	0	0	0	0	0	0	5	2.5	122
AUG	19	0	0	0	0	0	0	0	0.0	124

** VV=90-93 AND/OR N=4 COMP OB DAYS=COMPLETE OB DAYS

Wind

JULY WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.0	7.0	.0	.0	.0	7.0	14.4
NE	7.9	12.1	50.6	.0	.0	.0	65.6	13.0
E	3.7	6.3	12.7	.0	.0	.0	20.7	10.9
SE	3.7	3.3	1.0	.0	.0	.0	7.0	6.8
S	.8	.0	.0	.0	.0	.0	.8	3.0
SW	.0	.0	.0	.0	.0	.0	.0	.0
W	.0	.8	.0	.0	.0	.0	.8	4.0
NW	.0	.8	.0	.0	.0	.0	.8	8.0
CALM	2.5	.0	.0	.0	.0	.0	2.5	.0
TOTAL	18.5	21.3	60.4	.0	.0	.0	100.0	11.5

NUMBER OF OBS 122 — MAX WIND SPEED 21, DIR 080, DA HR 12 0600 — VECTOR MEAN SPEED 10.6, DIR 094 — (DIR IN DEGREES)

AUG WIND DIRECTIONS AND SPEEDS (% FREQUENCIES)

DIR	WIND SPEED (KNOTS) <4	4-10	11-21	22-33	34-47	>47	TOTAL	MEAN SPEED
N	.0	.0	2.0	.0	.0	.0	2.0	15.7
NE	.0	13.3	48.2	1.8	.0	.0	63.3	13.3
E	.0	6.7	20.2	.8	.0	.0	27.4	13.0
SE	.0	6.5	.4	.0	.0	.0	6.9	6.9
S	.0	.0	.0	.0	.0	.0	.8	8.0
SW	.0	.0	.0	.0	.0	.0	.0	.0
W	.0	.0	.0	.0	.0	.0	.0	.0
NW	.0	.0	.0	.0	.0	.0	.0	.0
CALM	.8	.0	.0	.0	.0	.0	.8	.0
TOTAL	.8	29.0	67.7	2.4	.0	.0	100.0	12.7

NUMBER OF OBS 124 — MAX WIND SPEED 22, DIR 070, DA HR 31 1800 — VECTOR MEAN SPEED 11.9, DIR 079 — (DIR IN DEGREES)

Wave

JULY WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	1.6	14.3	4.9	.0	.0	.0	.0	.0	20.9
NE	3.7	41.6	10.0	.0	.0	.0	.0	.0	55.3
E	2.9	11.7	3.1	.0	.0	.0	.0	.0	17.8
SE	.9	2.7	.9	.0	.0	.0	.0	.0	3.5
S	.0	.0	.0	.0	.0	.0	.0	.0	.0
SW	.0	.0	.0	.0	.0	.0	.0	.0	.0
W	.0	.0	.0	.0	.0	.0	.0	.0	.0
NW	.0	1.0	1.0	.0	.0	.0	.0	.0	2.7
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
CALM	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	9.0	71.3	19.7	.0	.0	.0	.0	.0	100.0

NUMBER OF OBS 122 — IND=INDETERMINATE

AUG WAVE DIRECTIONS AND HEIGHTS (% FREQUENCIES)

DIR	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
N	.0	2.0	.0	.0	.0	.0	.0	.0	2.0
NE	13.1	44.0	3.0	.8	.0	.0	.0	.0	62.9
E	6.7	19.6	.8	.0	.0	.0	.0	.0	29.8
SE	3.4	1.4	.0	.0	.0	.0	.0	.0	4.9
S	.8	.0	.0	.0	.0	.0	.0	.0	.8
SW	.0	.0	.0	.0	.0	.0	.0	.0	.0
W	.0	.0	.0	.0	.0	.0	.0	.0	.0
NW	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
CALM	.8	.0	.0	.0	.0	.0	.0	.0	.8
TOTAL	24.8	66.9	3.8	.8	.0	.0	.0	.0	100.0

NUMBER OF OBS 124 — IND=INDETERMINATE

JULY WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	7.4	53.3	4.9	.0	.0	.0	.0	.0	65.6
6-7	1.6	18.0	13.1	.0	.0	.0	.0	.0	32.8
8-9	.0	.0	1.6	.0	.0	.0	.0	.0	1.6
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	9.0	71.3	19.7	.0	.0	.0	.0	.0	100.0

NUMBER OF OBS 122 — MAX WAVE HEIGHT MGT 2.9, PER 4, DIR 090, TYPE SEA, DA HR 01 03 — IND=INDETERMINATE — (DIR IN DEGREES)

*ALSO OCCURRED ON PREVIOUS OBSERVATIONS

AUG WAVE PERIODS AND HEIGHTS (% FREQUENCIES)

PERIOD IN SECONDS	WAVE HEIGHT (METERS) <1	1-1.5	2-2.5	3-3.5	4-5.5	6-7.5	8-9.5	>9.5	TOTAL
<6	24.5	69.1	4.0	.0	.0	.0	.0	.0	96.8
6-7	.0	.8	1.6	.8	.0	.0	.0	.0	3.2
8-9	.0	.0	.0	.0	.0	.0	.0	.0	.0
10-11	.0	.0	.0	.0	.0	.0	.0	.0	.0
12-13	.0	.0	.0	.0	.0	.0	.0	.0	.0
>13	.0	.0	.0	.0	.0	.0	.0	.0	.0
IND	.0	.0	.0	.0	.0	.0	.0	.0	.0
TOTAL	24.8	69.9	5.6	.8	.0	.0	.0	.0	100.0

NUMBER OF OBS 124 — MAX WAVE HEIGHT MGT 3.0, PER 6, DIR 090, TYPE SWL, DA HR 04 18 — IND=INDETERMINATE — (DIR IN DEGREES)

For each observation, the higher wave of the sea/swell group was selected for summarization; if heights were equal, the wave with the longer period was selected; if periods were also equal, the sea wave was used.

Table 9
Selected Gale Observations, North Pacific
July and August 1973

Vessel	Nationality	Date	Position of Ship Lat. deg.	Position of Ship Long. deg.	Time GMT	Wind Dir. 10°	Wind Speed kt	Visibility	Present Weather code	Pressure mb	Temperature °C Air	Temperature °C Sea	Sea Waves* Period sec	Sea Waves* Height ft	Swell Waves Dir. 10°	Swell Waves Period sec	Swell Waves Height ft
NORTH PACIFIC		JULY															
MV OCEAN PRIMA	LIBERIAN	9	34.3 N	147.9 E	00	17	38	5 NM	60	1012.0	23.9	24.0					
MV MIDAS RHEIN	LIBERIAN	10	52.5 N	176.3 E	12	29 M	39	5 NM	02	1012.2	9.0	4.0	4	8			
SS ARGYLL	BRITISH	11	41.7 N	124.6 W	12	34	33	5 NM	05	1015.2	11.2	5.6	4	10	34	>13	10
MV PLUTOS	GERMAN	11	37.9 N	128.0 W	18	36	41	10 NM	05	1025.5	15.8	16.0	7	13			
SS PRESIDENT MADISON	AMERICAN	11	41.9 N	165.7 W	06	24	35	10 NM	03	1011.2	14.0	12.2	4	10	24	6	13
SS HILLYER BROWN	AMERICAN	12	38.2 N	125.3 W	05	33	35	10 NM	07	1016.6	11.7	13.3	5	8	34	9	11.5
SS J L HANNA	AMERICAN	12	39.5 N	125.1 W	18	36	35	10 NM	00	1013.5	17.2	12.2	4	5	01	7	19.5
SS GOLDEN GATE	AMERICAN	12	38.2 N	149.0 W	18	08	35	5 NM	69	1007.2	11.2	8.8	5	6.5			
SS ARGYLL	BRITISH	12	43.0 N	126.8 W	06	36	35	5 NM	02	1022.2	14.0	5.6	3	6.5			
MV PLUTOS	GERMAN	12	36.9 N	125.8 W	00	33	38	10 NM	01	1021.0	16.7	16.2	7	13			
USCGC GLACIER	AMERICAN	13	39.7 N	125.3 W	00	35 M	35	5 NM	02	1012.8	15.0	14.1	5	8			
SS HILLYER BROWN	AMERICAN	13	37.2 N	131.0 W	05	36	35	10 NM	09	1022.8	17.2	17.8	3	5	01	8	13
SS AVILA	AMERICAN	13	40.7 N	125.6 W	12	35	40	5 NM	03	1011.9	12.8	12.8					
USCGC YOCONA	AMERICAN	13	43.8 N	126.0 W	06	34 M	40	5 NM	09	1021.7	15.0	14.5	6	11.5			
SS SANTA MARIA	AMERICAN	13	42.3 N	124.5 W	12	32	38	5 NM	02	1016.3	10.0	8.3	2	5	32	7	13
USCGC GLACIER	AMERICAN	14	43.1 N	128.3 W	00	33 M	35	5 NM	01	1020.6	15.0	14.8	6	8			
SS AVILA	AMERICAN	14	42.0 N	127.3 W	00	36	40	10 NM	02	1016.3	17.2	10.0	7	18			
MV TRIUMPH	PANAMANIAN	14	48.7 N	129.0 W	12	32 M	37	< 50 YD	43	1023.7	11.5	15.0	6	14.5	27	6	16.5
SS SEATRAIN MAINE	AMERICAN	14	17.0 N	139.7 E	12	16	35	5 NM	38	1012.5	24.4	28.8	5	6.5			
MV MCGRAW	AMERICAN	15	37.8 N	137.0 W	06	09	35	5 NM	02	1025.1	18.4	18.9	5	8	05	10	13
SS PRES MCKINLEY (NEW)	AMERICAN	15	42.2 N	177.2 E	18	11	35	2 NM	21	996.3	15.6	13.0	3	8	13	8	11.5
SS MARJORIE LYKES	AMERICAN	15	34.5 N	168.2 E	06	28	39	10 NM	02	1004.5	21.7	19.4	3	5	28	< 6	10
SS PRES MCKINLEY (NEW)	AMERICAN	16	42.9 N	176.8 W	06	13	40	2 NM	10	1000.7	13.9	13.4	5	11.5	14	9	16.5
SS MALLORY LYKES NEW	AMERICAN	16	28.9 N	127.6 E	12	06	34 (E)	10 NM	02	1003.0	27.8	27.8	8	8			
MV SPINDRIFT ISLE	GERMAN	16	38.4 N	134.3 W	00	04	35	5 NM	02	1019.8	18.4	23.0	5	11.5			
MV HONSHU MARU	JAPANESE	16	30.2 N	174.7 E	18	09 M	38	5 NM	02	1009.5	7.0	7.5	8	16.5	11	>13	24.5
MV DONG HYUNG	KOREAN	16	43.2 N	173.8 E	06	24	35	.5 NM	47	994.0	12.0	12.0	10	23			
SS GOLDEN BEAR	AMERICAN	16	46.7 N	174.0 E	09	09 M	30	1 NM	10	989.9	9.5	7.0	14	32.5			
MV HONSHU MARU	JAPANESE	17	30.0 N	172.0 E	00	09 M	37	5 NM	10	1007.5	8.5	7.0	8	16.5	11	>13	24.5
SS KOREAN MAIL	AMERICAN	17	30.2 N	124.2 E	12	06	45 (E)	5 NM	02	999.0	27.3	27.0	5	13	09	6	16.5
SS SAN JUAN VANGUARD	LIBERIAN	18	28.3 N	128.1 E	11	16	40 (E)	5 NM	03	995.0	29.0	31.0	6	8	16	7	16.5
MV SAN BRUNO	SWEDISH	18	26.5 N	124.0 W	12	25	35 (E)	1 NM	97	990.0	25.5		7	6.5	24	8	14.5
SS JOSEPH LYKES	AMERICAN	18	22.4 N	124.3 W	12	23 M	44 (E)	5 NM	01	996.3	28.8	29.4	10	21	24	>13	23
SS GENEVIEVE LYKES	AMERICAN	18	32.3 N	128.3 E	12	16	30 (E)	5 NM	02	997.0	26.7	28.1	8	14.5			
SS COLORADO	AMERICAN	18	28.4 N	126.6 E	06	15	35 (E)	.5 NM		995.6	25.0	25.0	5	13			
SS KOREAN MAIL	AMERICAN	18	33.2 N	127.0 E	00	11	45 (E)	5 NM	00	996.5	26.7	26.7	5	14.5	18	10	16.5
SS AMER CORSAIR	AMERICAN	18	10.3 N	107.3 W	06	18	38 (De)	1 NM	02	1011.2	29.8	28.8	8	16.5			
SS SAN JUAN VANGUARD	LIBERIAN	19	23.6 N	124.3 E	11	22	40 (E)	5 NM	02	998.0	31.0	30.5	8	8	32	7	16.5
SS GENEVIEVE LYKES	AMERICAN	19	30.5 N	126.9 E	00	14	43 (E)	5 NM	62	992.0	25.6	26.7	4	13	16	8	16.5
SS VIRGINIA TRADER	AMERICAN	20	32.9 N	140.8 E	06	10	39 (E)	10 NM	03	1009.8	27.3	28.8					
SS KEYTANKER	AMERICAN	21	16.7 N	100.6 W	22	11	34(E+)	10 NM	02	1008.4	29.4	30.6	5	11.5			
MV SPINDRIFT ISLE	GERMAN	22	37.2 N	125.4 W	12	33	37	10 NM	00	1013.8	14.2	14.8	6	13	31	8	18
MV RITA MAERSK	DANISH	22	16.9 N	101.4 W	12	10	40(E+)	5 NM	82	1005.0	29.5	31.0					
SS MARYMAR	AMERICAN	22	30.5 N	116.5 W	06	31	38	10 NM	02	1010.5	17.0	17.8	5	5	31	< 6	8
SS KEYTANKER	AMERICAN	22	16.2 N	100.6 W	06	10	45(E+)	5 NM	62	1014.0	28.7	29.4					
SS EXPORT COMMERCE	AMERICAN	22	15.1 N	97.5 W	03	13	45(E+)	5 NM	39	1011.0	25.0	28.3	2	10	13	6	13
SS SEALAND TRADER	AMERICAN	23	43.7 N	169.3 E	06	17	41	.5 NM	61	1002.5	13.4	8.8	4	8.5			
SS CHEVRON TRANSPORTER	LIBERIAN	23	17.9 N	103.1 W	18	15	35(E+)	5 NM	62	1011.0	26.0	29.0	6	16.5	21	9	19.5
SS HAWAIIAN	AMERICAN	23	32.9 N	120.7 W	12	36	35	10 NM	02	1010.2	15.0	16.1	4	6.5	32	6	16.5
MV HOSOM MARLYN	NORWEGIAN	23	18.4 N	103.9 W	12	13	35(E+)	10 NM	02	1009.0	28.4	30.0					
MV GLOMAR CHALLENGER	AMERICAN	23	31.7 N	133.7 E	00	05 M	43	2 NM	61	1000.8	26.8	27.0	7	11.5			
SS SANTA MARIA	AMERICAN	24	39.0 N	123.9 W	00	32	35	> 25 NM	02	1017.9	12.8		3	6.5	32	< 6	8
SS CHEVRON TRANSPORTER	LIBERIAN	24	18.6 N	104.3 W	18	09	35(E+)	5 NM	61	1010.0	26.0	28.0	6	16.5	18	10	19.5
MV IRISH STAR	IRISH	24	33.7 N	120.6 W	06	33	37	10 NM	02	1014.6	13.8	15.0	4	6.5			
SS HAWAIIAN	AMERICAN	24	32.2 N	123.9 W	00	34	40	10 NM	02	1018.0	18.3	16.7	4	6.5	34	7	13
SS J H TUTTLE	AMERICAN	27	39.6 N	126.8 W	00	33	35	10 NM	02	1015.2	17.2	15.6	3	5			
SS ARCO COLOMBIA	LIBERIAN	27	17.0 N	101.8 W	18	09	35(E+)	2 NM	61	1008.0	27.8	28.3	12	19.5			
SS SHIRLEY LYKES	AMERICAN	27	14.1 N	100.6 W	09	22	35(E+)	10 NM	02	1009.1	25.6	26.3	2	9	23	7	11.5
MV IRISH STAR	IRISH	28	18.1 N	103.3 W	00	10	40(E+)	5 NM	16	1007.2	25.6	22.2	7	11.5			
SS CALIFORNIAN	AMERICAN	28	18.2 N	103.2 W	00	11	35(E+)	5 NM	61	1006.4	25.6	30.0	5	8			
SS ARCO COLOMBIA	LIBERIAN	28	18.1 N	103.5 W	00	10	35(E+)	5 NM	03	1007.0	28.0	27.7	8	16.5			
SS SEAMAR	AMERICAN	28	17.0 N	102.3 W	06	15	35(E+)	10 NM	18	1010.5	27.2	28.3	3	6.5	12	6	13
SS SHIRLEY LYKES	AMERICAN	28	14.1 N	104.8 W	00	23	35(E+)	10 NM	60	1009.0	25.0	27.8	2	6.5	23	7	11.5
NORTH PACIFIC		AUG.															
OSWEGO PATRIOT	LIBERIAN	1	35.7 N	142.3 E	18	22	42	5 NM	03	1011.5	27.0	27.3	4	11.5			
SS SEALAND TRADER	AMERICAN	1	47.2 N	177.3 E	18	26	40	5 NM	07	992.2	8.9	11.1	10	16.5	26	12	19.5
SS SEALAND TRADER	AMERICAN	2	48.4 N	173.0 E	00	28	37	5 NM	07	1007.5	11.2	10.7		16.5			
SS SUMMIT	AMERICAN	2	54.3 N	164.7 W	12	10	40	10 NM	02	1001.0	9.4	8.3	6	6			
SS ARCO SAG RIVER	AMERICAN	3	40.1 N	125.8 W	18	36	39	5 NM	03	1017.1	13.0	14.0	7	9	36	7	10
SS SUMMIT	AMERICAN	3	57.8 N	153.1 W	18	07	36	2 NM	80	998.3	10.0	11.1	6	8.5			
SS ARCO SAG RIVER	AMERICAN	4	42.3 N	128.8 W	06	36	38	2 NM	10	1023.1	16.0	14.0	5	5	36	7	10
MV EMMA JOHANNA	GERMAN	5	30.8 N	174.0 E	03	28	37	5 NM	05	1012.0	23.8	24.0	6	11.5	24	8	14.5
SS FAIRSEA	LIBERIAN	11	39.6 N	126.3 W	12	36	40	5 NM	02	1013.0	14.0						
SS SAN PEDRO	AMERICAN	11	24.9 N	127.6 E	12	36	35	10 NM	15	1003.7	27.8	28.3	5	8	10	10	11.5
MV PHIL PRES MAGSAYSAY	PHILIPPINE	13	14.7 N	94.3 W	12	06 M	38	5 NM	18	1011.5	29.0	30.5					
CHEVRON HAWAII	AMERICAN	13	43.9 N	173.6 E	12	36	35	1 NM	53	1008.3	15.3	9.4	4	8	31	8	8
MV LICA MAERSK	DANISH	14	32.2 N	137.3 E	00	10	40(I)	.5 NM	29	1009.9	27.6	29.0					
MV PEARL VENTURE	LIBERIAN	14	53.6 N	175.5 W	06	17 M	33	2 NM	81	1011.9	8.5	9.5	8	8			
CHEVRON HAWAII	AMERICAN	14	44.7 N	171.1 E	00	26	37	10 NM	28	1008.2	15.0	12.2	6	10			
SS AMER MAIL	AMERICAN	15	29.2 N	124.1 E	06	36	35(I)	5 NM	02	997.1	31.1	29.8	3	6.5	36	< 6	10
SS AMER MAIL	AMERICAN	16	30.6 N	125.0 E	00	34	40(I)	5 NM	02	997.5	28.7	28.3	7	11.5	28	12	13
MV GLOMAR CHALLENGER	AMERICAN	19	40.6 N	134.4 E	18	29 M	35	5 NM	02	1009.1	20.0	22.2			23	8	8
CHEVRON HAWAII	AMERICAN	20	23.4 N	125.4 E	12	10	40(I)	5 NM	02	1009.0	28.7	28.6	3	10	18	>13	11.5
SS LOUISE LYKES	AMERICAN	20	22.0 N	128.8 E	06	13 M	38(I)	5 NM	80	1007.1	27.8	27.7	8	14.5			
SS GOLDEN GATE	AMERICAN	21	37.4 N	123.1 W	06	32	39	> 25 NM	02	1016.2	12.7	13.3	3	6.5			
MV ROBERTS BANK	LIBERIAN	21	52.7 N	158.8 W	00	18	35	5 NM	62	1015.5	13.0	10.0	8	6.5			
MV VAN TRIUMPH	LIBERIAN	22	48.2 N	172.4 E	18	18 M	38	2 NM	62	998.0	13.0	11.0					
MV ROBERTS BANK	LIBERIAN	23	50.8 N	179.7 E	12	24 M	45	5 NM	02	997.0	9.8	8.0	4	13			

Vessel	Nationality	Date	Position of Ship		Time GMT	Wind		Visibility	Present Weather code	Pressure mb	Temperature °C		Sea Waves?		Swell Waves		
			Lat. deg.	Long. deg.		Dir. 10°	Speed kt				Air	Sea	Period sec	Height ft	Dir. 10°	Period sec	Height ft
NORTH PACIFIC		AUG.															
MV CAP CARMEL	GERMAN	23	31.9 N	118.9 W	06	31	35	10 NM	02	1015.6	17.7	18.6	5	11.5			
MV VAN THIJEN	LIBERIAN	23	47.9 N	171.0 E	00	22	M 38	2 NM	60	999.0	13.0	11.0					
MV SAN JUAN EXPORTER	LIBERIAN	24	10.6 N	108.1 W	06	22	40	2 NM	21	1001.1	28.0	30.0	9	19.5			
SS PACIFIC ARROW	PANAMANIAN	24	52.8 N	153.8 W	12	27	M 35	5 NM	58	1010.5	11.0		7	6.5			
SS IDAHO STANDARD	AMERICAN	24	54.3 N	165.8 W	06	27	33	10 NM	02	997.0	10.1	11.1					
SS CHRYSANTEMA	BRITISH	25	19.3 N	143.5 W	00	07	35	5 NM	02	1016.8	27.0	28.0	8	6.5			
SS HAWAIIAN	AMERICAN	25	34.8 N	131.8 W	06	35	35	10 NM	02	1021.0	20.0	21.1	6	6.5			
SS SEALAND GALLOWAY	AMERICAN	29	47.4 N	167.4 E	12	30	35	10 NM	02	1000.0	13.3	16.2	5	8			
SS BOSTON	AMERICAN	31	13.0 N	93.0 W	00	24	40(H+)	5 NM	21	1005.1	26.2	30.0	3	8	24	6	11.5
SS JAMES LYKES	AMERICAN	31	34.8 N	148.9 E	18	05	35	10 NM	16	1018.0	24.4	28.3					
SS SANTA MARIA	AMERICAN	31	55.9 N	143.4 W	18	14	35	5 NM	80	1000.0	11.1	12.2	5	8	14	6	19.5
SS TEXAN	AMERICAN	31	15.4 N	95.6 W	21	14	34(H+)	.25 NM	64	1000.5	26.1	29.4			21	>13	26

\+ Direction for sea waves same as wind direction
X Direction or period of waves indeterminate
M Measured wind

(B) Typhoon Billie
(D) Typhoon Dot
(E) Typhoon Ellen
(I) Typhoon Iris
(J) Tropical storm Joan
(D+) Hurricane Doreen
(E+) Hurricane Emily
(F+) Hurricane Florence
(H+) Tropical storm Heather

NOTE: These observations are selected from those with winds of 35 kt or higher. In cases where a ship reported more than one observation a day with such winds, the observation with the highest wind speed was selected. In cases where two or more observations had the same wind speed, the one at 1200 GMT or the one closest to 1200 GMT was chosen. If this method still did not break a tie, the one with the lowest barometric pressure was picked. The data for the Ocean Station Vessels are based on 3-hr observations. In a good many cases, the maximum wind speeds given in the U. S. Ocean Station Climatological Data tables are higher because these are based on the Summary of Day entries.

Rough Log, North Atlantic Weather

October and November 1973

ROUGH LOG, OCTOBER 1973--As could be expected in a transitional month, the storm tracks were diffuse. According to climatology, the primary track should extend from near Belle Isle northeastward, south of Iceland to the northern shore of Norway. There are several secondary tracks: one off the United States east coast, one south of the primary track south of Iceland, and one in the Mediterranean Sea. The actual primary storm track originated off Nova Scotia, south of Newfoundland, and tracked north-northeastward through the Denmark Strait. The tracks across the northern United States and Canada were very diffuse, with no favorite path or direction except easterly. Two storms wandered around the Sargasso Sea, north of Puerto Rico. Three LOWs formed and wandered about in the area between the Azores and Spain prior to moving northward. Also, three storms made the Mediterranean Sea their home.

The pressure pattern did not have any outstanding features. It closely paralleled the climatological pattern. The Azores High was normally located, and the 1020-mb center was the same as climatology. The Icelandic Low was near 58°N, 43°W, approximately 600 mi southwest of its normal location, and 4 mb higher in pressure at 1006 mb. A trough off Newfoundland reflected the location of the primary storm track. The eastern Atlantic had higher than normal pressures. Also, a high-pressure center was located over northern Greenland. The eastern half of the United States was normal.

The large anomalies were positive this month. The largest was 12 mb over Greenland, which connected with a 10-mb center near 59°N, 14°W, between Iceland and Scotland. The eastern two-thirds of the Mediterranean was 1 to 2 mb below normal. The only area of negative anomalies was a large area off the east coast of North America.

There were two tropical cyclones this month--hurricane Fran and tropical storm Gilda. They are described in the annual article, "North Atlantic Tropical Cyclones, 1973," on page 8. Normally, October produces two tropical cyclones, one of which will develop to hurricane intensity.

An anemic 1012-mb wave developed on a cold front just west of Lake Michigan on the 4th. It moved eastward, slowly deepening until, on the 6th, it was a 990-mb LOW over Anticosta Island. At 1200, the drilling rig VGBZ reported 50-kt winds in the Gulf of St. Lawrence. The ALERT, south of Newfoundland, experienced 35-kt gales. Twenty-four hours later, at 1200 on the 7th, the VGBZ had roaring 65-kt winds from the northwest (fig. 40). The seas were 18 ft. To the south, the ALERT now was buffeted by 45-kt gales.

As the LOW moved over St. John's, it filled slightly and the gradient weakened. Forty-knot winds in the northern quadrant were the strongest plotted. At 0000 on the 9th, near 43.6°N, 43.8°W, the ZCEJ found 45-kt gales about 600 mi south of the LOW's center. Thirty-five- and forty-knot winds continued to blow all around the center.

On the 10th and 11th, the LOW again intensified and executed a loop in the vicinity of 50°N, 40°W. The ALBATROS, near 46°N, 43.6°W, was headed into 45-kt gales, and the VC8062, at 47°N, 48.7°W, was pounded by 50-kt winds and 30-ft swells from the north. As the storm continued its loop, the gradient on the northwest side remained very tight, and 35- to 40-kt winds were common.

On the 11th, hurricane Fran passed south of the center. At 1200 on the 11th, Fran was near 40°N, 34°W, while the LOW was near 51°N, 43°W. The MOORDRECHT, off the Labrador coast, was fighting 40-kt winds, 16-ft seas, and 26-ft swells. High seas were reported all around the center.

As Fran moved to the northeast and east of the LOW, the LOW started an easterly track behind the former hurricane. The pressure was now rising again, and only minimal gale-force winds were reported. It was not until the LOW neared the continent on the 15th that

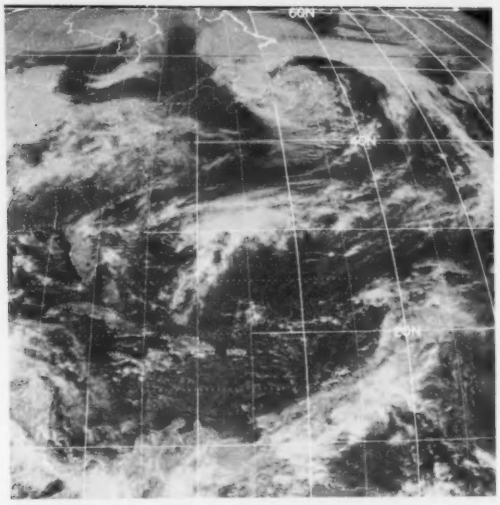

Figure 40.--Those 65-kt winds can almost be seen in the cloud bands around the LOW in this satellite picture at 1558.

it partially regained its strength. The BALD EAGLE reported that the searchlight door burst open due to heavy weather and flooded the port tunnel. The SL181, north of the Azores, found 40-kt gales. The H. R. MACMILLAN and Ocean Station Vessel "K" had 35-kt winds and seas to 15 ft. At 1200 on the 16th, after passing over Brest, a ship had 45-kt winds in the Bay of Biscay. The CHERTAL, near 51°N, 12.5°W, had 40-kt winds on her starboard side. The LOW now passed over the Low Countries and into eastern Europe.

This short-lived storm started out as a tropical depression, on the 10th, in the wake of hurricane Fran. At that time, it was located at about 24°N, 70°W, at 1009 mb. The trough became sharper as the LOW moved toward the northeast, but only developing slightly. At 0000 on the 12th, the 1006-mb center was near 30°N, 61°W. Twelve hours later, frontogenesis was indicated with a new center to the northeast. Northwest of the center, near 37.5°N, 59.3°W, the DJVO was bucking 50-kt headwinds, as was the HILVERSUM with 35 kt. On the opposite side of the LOW, the NIENBERG and SOLON TURMAN found 35-kt gales from the southwest.

On the 13th, the northeasternmost LOW broke away and sped off toward the northeast. The original depression wandered in the same area, forming a loop with its track. By the 14th, it was squeezed out of existence by two large HIGHs.

As the second LOW sped to the northeast, it treated the VARNA to 35-kt gales on the 13th, near 38°N, 39°W. On the 14th, Ocean Station Vessel "K" was not slighted, as she had 40-kt gales and 16-ft seas.

A large low-pressure area moved out of the Great Lakes and north into the Davis Strait. A trough stretched south through the Labrador Sea and across Newfoundland. South of Newfoundland, on the 19th, a small 1012-mb LOW developed in the trough. The LOW was a quick developer, as it traveled to 52°N, 46°W in 24 hr and the pressure plunged to 976 mb. The ATLANTIC CINDERELLA had a preliminary taste of the small, intense storm, at 1200 on the 20th, near 49.5°N, 44.5°W, with 40-kt winds. The tightly wound circulation continued northeastward at about 30 kt. At 0000 on the 21st, the VASSILII SOURIKOV passed almost through the center and reported 35-kt winds at that time. Ocean Station Vessel "C," in the southeast quadrant, also measured 35-kt winds. At 1200 that day, the AMERICAN ACE, about 400 mi south of the center, raced against 40-kt winds in 18-ft seas and 20-ft swells.

At 1200 on the 22d, the 978-mb LOW moved over the western tip of Iceland, and the EDITH NIELSEN, near 62°N, 20°W, was hounded by 45-kt gales. The LOW continued its headlong plunge northeastward into the Greenland Sea and to the Svalbard Islands on the 24th.

This storm was multinational, as it moved eastward along the United States and Canadian border, finally moving to sea over Cape Cod late on the 20th. At that time, the central pressure was only 1013 mb. Development came later, after it was over open water and the Gulf Stream.

At 1200 on the 22d, the 994-mb LOW was east of St. John's, near 46°N, 46°W. Twenty-four hours later, at 1200 on the 23d, the 972-mb LOW was near 56°N, 38°W. The QUEENSGARTH, at 56°N, 40°W, had a rough go of it, with 20-ft seas and 20-ft swells driven by 45-kt north winds. The ARVIDSJAUR, on the opposite side of the center, near 55.5°N, 27°W, had 40-kt southerly gales.

The storm was following nearly the same track as the previous storm. This is reasonable if no major change has occurred in the long-wave upper air pattern. At 0000 on the 24th, the 966-mb LOW was at 61.5°N, 33.5°W. The KRAS and SVENDBORG, 110 and 70 mi south of the storm, respectively, were both mauled by 45-kt winds and seas to 25 ft. As the storm passed into the Denmark Strait, Ocean Station Vessel "A" was bounced about by 40-kt winds and 25-ft seas, while maintaining her station.

As the LOW passed through the Denmark Strait, it appeared that the squeezing developed two other LOWs; one near Kap Farvel and the other in the Greenland Sea. It was like squeezing a balloon with your hand. At 1200 on the 25th, the two other LOWs had taken over the circulation and only a col area remained.

In monetary value, this storm was the worst of the month. It occurred in the Mediterranean Sea and, as far as a closed circulation was concerned, lasted less than 48 hr. Damage to Palermo and port facilities was estimated at over $200 million.

As background on this vicious storm, on the 24th, a weak front had pushed south over the mountains into Italy as high pressure moved eastward from France into central Europe. Lower pressure existed over the eastern Mediterranean. On the 0000 chart of the 25th, the front could no longer be supported, but a slight inverted trough which was present on the 24th intensified on the 25th to a 1009-mb LOW, south of the toe of Italy. Only 10- to 20-kt winds were reported at that time. On the 0600 chart, Naples reported

Figure 41.--The Italian tanker CONCA D'ORO was driven aground in the Palermo, Sicily, harbor. The gale-force winds and rough seas tossed large ships and drydocks about like toys. Wide World Photo.

35-kt gales, but all other reports were average. By 1200 on the 25th, the LOW had deepened to 1004 mb and remained essentially stationary. The HIGH to the north was drifting southeastward very slowly. The 1200 and 1800 charts did not indicate anything abnormal. The LOW had dropped to 1002 mb by 1800. A 30-kt onshore wind was measured at Tunis and 25-kt at Livorno. A circulation out of the northeast had been blowing across the Tyrrhenian Sea for several days.

The storm struck the night of the 25th and morning of the 26th. Rainfall was reported for 24 hr. The 0000 chart of the 26th indicated 50-kt northeasterly winds at Palermo, but other reports referred to hurricane-force (64 kt or more) winds. Thunderstorms with hail were reported in the area, and the violent winds were probably associated with these.

By 1200 on the 26th, the center of the LOW had moved westward to near the northeast tip of Tunisia. The central pressure was 1003 mb. By 0000 on the 27th, the closed circulation had broken down, and only an inverted trough remained as before.

First reports indicated nine ships were sunk. The CONCA D'ORO (fig. 41) was aground, an 8,000-ton Bulgarian freighter and a 480-ton ship were sunk, but all crewmen were rescued. Many small boats were damaged or destroyed (fig. 42). Two 50,000-ton and one 19,000-ton drydocks were adrift or grounded. One contained the 54,908-ton TEXACO WESTMINSTER when it broke adrift and grounded in force 9 winds. The ship was knocked off its blocks and the bottom

Figure 42.--This aerial photo shows some of the many small boats and craft that were sunk, damaged, or destroyed by the viscous storm. United Press International Photo.

extensively damaged.

The waves smashed some 2,000 ft of seawall, and jetties and breakwaters were crumbled. The wind and seas uprooted trees and flooded streets as 24 hr of continuous rain contributed to the high water. Communication and electric powerlines were broken.

This LOW developed early on the 24th, off the coast of Portugal, on a front that had moved across the Atlantic and nearly stalled as it stretched southward between two HIGHs. The KANAGAWA MARU, at 47°N, 20°W, approximately 180 mi north of the 1013-mb center, was hit by 40-kt gales. The LOW was squeezed southward by the two high-pressure areas. At 1200 on the 28th, the VELIKIYE LUKI found 40-kt winds and 26-ft swells northwest of the center.

At 0000 on the 29th, the LOW was near 40°N, 20°W, as the western HIGH moved north of the LOW and across Ireland, in response to pressures exerted by extratropical Gilda. As the HIGH moved eastward, the LOW deepened to 1003-mb on the 30th and moved in a northerly direction. Although the central pressure dropped, the gradient relaxed, and strong winds and high waves were no longer being reported. As the LOW moved north, it lost its individuality as it was absorbed in the large-scale cyclonic circulation.

Monster of the Month--Extratropical Gilda--Gilda was the type of storm that makes meteorology interesting and forecasters prematurely gray or pull their hair out. After dilly-dallying in the Bahamas, she started moving northeastward, and this is when she really developed. By 1800 on the 27th, Gilda was near 43.5°N, 59°W (fig. 43), and extratropical. Gale-force winds were

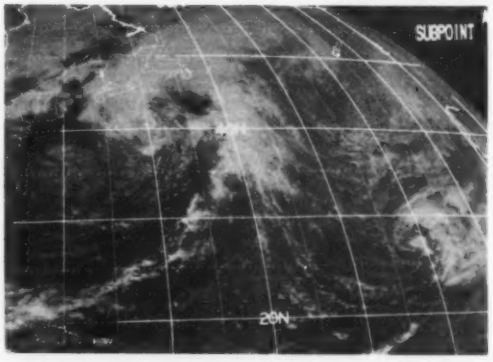

Figure 43.--Gilda was tame, as a tropical cyclone, in comparison with her viscous winds and seas after becoming extratropical. She also covered a much wider area.

reported in all quadrants of the storm on the 27th. Among the ships reporting were the AMERICAN ALLIANCE, ATLANTIC CHAMPAGNE, OSWEGO UNITY, and SEDCO I. The LOW was speeding northeastward at 33 kt, and the central pressure was still dropping. By 1200 on the 28th, the storm was centered at 51.3°N, 48.3°W. At 0000, the NORTHERN SHELL, near 42.5°N, 54°W, struggled with 50-kt winds about 120 mi from the center. Gale-force winds were reported as far as 550 mi from the center. The VC8062 was hammered by 26-ft seas. At 1200, the C. P. VOYAGEUR was walloped by 55-kt portside winds and KIDRIC B was mauled by 50-kt winds and 23-ft seas. Both were northeast of the storm center.

The storm reached its maximum on the 29th, with a pressure of 966 mb. At 0000 it was located near 57.6°N, 43°W The C. P. VOYAGEUR, at 53.4°N, 37.7°W, which was about 280 mi southeast of the center, was ravaged by 75-kt hurricane-force winds from 190°. I would suspect that if someone asked how you handled a ship in such a situation, the reply would be "Very carefully." From subsequent plots the VOYAGEUR was headed westward, but for this period of time she appeared to be almost stopped. Kap Farvel reported 50-kt winds and snow. Ocean Station Vessel "B" and two other ships in the Labrador Sea had 45-kt gales. The DUKESGARTH was engulfed by 28-ft seas, near 51.3°N, 44.4°W, about 300 mi due south of the center.

At 1200 that day, the torrent was still raging. The KRAS, near 55°N, 51°W, was headed west toward Hamilton Inlet and being mauled by 65-kt northwest winds ("wind" hardly seems a strong enough term) and 30-ft seas. In the past 24 hr, she had steamed from one side of the storm to the other, almost through the center; from 50-kt southerly winds to 65-kt northwesterly. The NANOK S, about 180 mi east of the center, which was 70 mi southeast of Kap Farvel, was heading into 60-kt southerly winds and 33-ft waves. Twelve hours later, the winds had calmed to 45 kt, with 20-ft seas topping 26-ft swells. Ocean Station Vessel "A" was suffering 40-kt winds and 30-ft seas. Gale-force winds extended 750 mi south of the center.

On the 31st, the storm was filling rapidly and stalled near 65°N, 37°W, over the cold water of the Denmark Strait.

Casualties--The 15,028-ton MARATHONIAN and the Norwegian RALWY collided head-on in dense fog on the night of October 2, in the Mackinac Straits. There were no injuries, but both ships had to enter drydock facilities for repairs.

Fog was again the culprit in the collision of the 22,248-ton Norwegian bulk carrier SNEHOLT and a small West German coastal vessel early in the month. The coastal vessel capsized, but remained afloat. Six of the crew were rescued, but the master was reported missing.

There is no indication that weather was involved, but a real-life "Poseidon Adventure" happened when the French dredger CAP DE LA HAGUE capsized off Calais. French Navy divers rescued one man from the overturned dredge, but six others were not rescued. In another capsizing, the last week in the month, rough seas overturned a trawler which sank off the Devon Coast. A 13-yr-old boy was trapped inside. Frogmen tried to rescue him, but there were no air pockets, as the ship landed upright on the bottom. Four men swam in the sea for 30 min before being rescued by a fishing vessel.

The 9,041-ton Turkish FIRAT sustained heavy weather damage on the 15th. Heavy lifts broke stowage in upper 'tween decks. On the 18th, the dredger PITTSBURG broke tow with the tug GWYNEDD in weather off Cape Hatteras. The dredger sank, and an oil barge was recovered. There were no injuries.

ROUGH LOG, NOVEMBER 1973--Only in the overall pattern did the storm tracks compare with the climatological mean tracks; that is, they were southwest to northeast. The mean track across the United States was further south; a primary track just off the United States east coast toward Newfoundland did not exist; a secondary track slightly west of midocean was a primary track and more northerly; the primary track south of Greenland and over Iceland curved east-southeastward into the Baltic Sea, rather than off the Norwegian coast.

Since the mean cyclone tracks and the mean pressure pattern have a direct relationship, the mean pressure pattern would almost necessarily differ from the climatological mean, with large anomalies. This was the case.

The 1000-mb Icelandic Low was near 55°N, 57°W, some 800 mi southwest of its 1001.8-mb climatic position. The 1020.7-mb climatological Azores High was the 1025-mb Bay of Biscay High this month, just west of Bordeaux. A trough stretched southeasterly from the mean Low toward the Azores, where the climatic High would normally be. A closed 1021-mb High was located over the southeastern states and bulged eastward over the ocean. A large 992-mb Low was centered east of Murmansk and dominated Eurasia north of 50°N. Interestingly, the Asian High was normally located and 4-mb higher in pressure; thus, the gradient around the Low was very tight.

The anomaly chart was a mass of concentric circles. A minus 9-mb anomaly was located just south of the mean Low over Belle Isle. A minus 19-mb departure was centered over the entrance to the White Sea. The largest positive anomaly was 17 mb, centered over central Greenland. A plus 11-mb center was west of Ireland, about 54°N, 18°W, and a plus 4-mb centered about 550 mi east of Miami. The trough, southeastward out of the so-called Icelandic Low, was reflected by an anomaly trough along the same line.

November is the end of the tropical cyclone season, except for two which have occurred in December during the last 43 yr. During that period of time, 16 have occurred during November, with 7 developing into hurricanes. There were none this month.

This storm came out of the Great Lakes on the 1st. By 0000 on the 2d, it was near the Bay of Fundy, with a pressure of 973 mb. The strong winds were behind the cold front and mostly on the back side of the trough just off the coast. The WALTER HERWIG, at 42.5°N, 68.5°W, was pounded by 50-kt winds and 16-ft seas. The PJSU found 45-kt gales, and the STOLT LLANDAFF and the USCGC TANEY had 40-kt gales. Twelve hours later, the GULF HANSA was taking 50-kt winds and 36-ft seas on her port side, 120 mi southeast of Cape Sable (fig. 44).

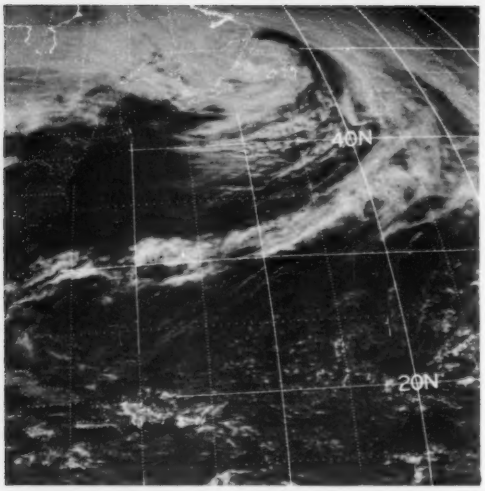

Figure 44.--The LOW is shown over Newfoundland on the 2d, on its journey to Labrador.

On the 3d, the 974-mb storm moved north-northeastward and, at 0000 on the 4th, was near Goose Bay, Labrador. SEDCO J measured a howling 60-kt wind. The PAVLOVO, over the Sable Island Bank, was lashed by 50-kt winds and 23-ft seas. Inside the Gulf of St. Lawrence, VGBZ was swept by 60-kt storm winds and, in the short fetch, 18-ft seas. Gale winds were blowing as far as 1,000 mi south of the center. For over 36 hr, Ocean Station Vessel "B" suffered winds of 45 to 50 kt.

The LOW was moving slowly up the Labrador coast and the gradient weakening. Several LOWs with frontal waves had moved around its edge. The central pressure was slowly rising as it drifted in the Labrador Sea.

This was the LOW that absorbed the previous storm. At 1200 on the 8th, it was a 1000-mb cyclone, just south of James Bay. At 0600 on the 10th, it moved through the Strait of Belle Isle and was a 976-mb storm. The C. P. DISCOVERER, near 53°N, 50°W, was rocked by 45-kt gales. Off Cape Race, a ship reported 55-kt winds from the south prior to frontal passage.

On the 11th, the LOW was 970-mb and moving up the Davis Strait. Ocean Station Vessel "B" was getting no respite, as she measured 50- and 60-kt winds until 1200 on the 12th. Kap Farvel had a blizzard going on, and the NORMAN MCLEOD ROGERS, off Hebron on the Labrador coast, had 45-kt northwesterlies. Ships were reporting 35- to 45-kt gales over 700 mi to the southeast. The LOW split into two LOWs as it moved past Kap Farvel, with the LOW in the Denmark Strait being the most vicious. At 0000 on the 12th, the BJARNI SAEMUNDSSON, at 65.6°N, 31.6°W, was engulfed by 60-kt winds and heavy snow. At 1200 on the 12th, the Davis Strait LOW had dissipated and the Denmark Strait LOW was racing eastward. Forty- to fifty-knot winds were still the order of the day. A

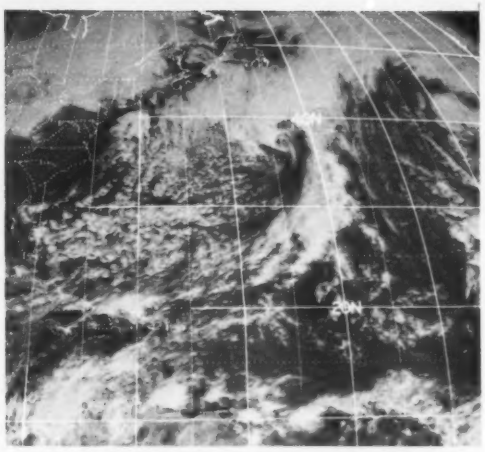

Figure 45.--The cyclonic circulation is not so well-defined in the cloud pattern of this LOW, but it has the distinction of the close-in cloud pattern, looking like the symbol for a hurricane.

Danish coastal station reported 40-kt winds. At 0000 on the 13th, the LOW was near Bergen, Norway, and Stavanger reported 40-kt, and a Netherlands coastal station felt a 45-kt maelstrom. At 1200, the station reported 50-kt. The LOW moved into northern Russia, where it stalled near the White Sea, to be reinforced later by other LOWs.

This was a short-lived LOW, which formed east of Bermuda, near 34°N, 58°W, on the 11th. Gale winds were reported on the west side, with its inception. At 1200 on the 12th, the pressure had dropped to 1002 mb, near 39°N, 54°W (fig. 45), and the KANAGAWA MARU, which was less than 100 mi northwest of the center, was buffeted by 50-kt winds and 23-ft seas. As it moved northeastward off the Grand Banks, the drilling rigs were lashed by 40-kt gales. SEDCO I reported the worst lashing of 45 kt, at 1200 on the 13th. For some reason, the LOW then was filling rapidly and dissipated on the 14th.

An upper-air trough was over the southern part of the central Atlantic at this time. This was reflected at the surface by a series of waves forming on the front that was associated with the previously described LOW. At 0000 on the 15th, a 999-mb LOW center formed near 27°N, 45°W. The NORTHERN STAR was on the 1000-mb isobar and very near the center. She reported heavy rain and 35-kt winds. The storm was moving northward and, at 0000 on the 16th, was near 31.5°N, 40°W. The MEDEA, at 30.9°N, 40.9°W, was about to pass through the center with 40-kt winds, as the LOW took an easterly course. Twelve hours later, several other ships were feeling the storm's wrath, as it increased in size. The FRIESENSTEIN was to suffer the worst, with 50-kt westerlies near 27.5°N, 39.8°W. Northwest of the center, the ALEMANNIA combated 45-kt gales and 20-ft seas. At 0000 on the 17th, the 992-mb LOW was moving due east. The

CITY OF OTTAWA was headed into 40-kt winds, southeast of the center.

The LOW was now stacked vertically, with an upper air cutoff LOW, and drifting eastward, while gradually filling. The gradient would no longer support gale-force winds, but the cyclonic circulation persisted until the 24th.

Monster of the Month--A high-pressure center moved eastward out of the United States midwest. On the 19th, it split into two centers, one over Georgia and one east of Bermuda. To the north, a small LOW developed off the New Jersey coast. Frontogenesis quickly occurred, as multiple waves moved eastward. These were shallow and difficult to trace from one chart to another.

By 1200 on the 21st, one had developed to 994-mb near 39°N, 49°W. The LASH TURKIYE, near 38°N, 59°W, found 45-kt gales. The SIRARA and SUGAR CRYSTAL, almost equidistant northwest and southeast of the center, were buffeted by 35-kt gales. This LOW was caught up in the northeastward flow of the upper-air trough and dashed off to the north-northeast. At 1200 on the 22d, the CRYSTAL SAPPHIRE, near 49°N, 44.5°W, and only about 100 mi from the center, was beaten by 50-kt winds.

In the meantime, another center had developed near 32°N, 49°W. The EXPLORER was immediately caught in heavy, continuous rain, blown by 45-kt winds.

This new LOW became the center of attention, as it developed and the other scooted across the top of ridge to bring 40-kt winds to the coasts of the Low Countries. On the 24th and 25th, I found no reference to damage, but there must have been flooding along those coasts, as the winds persisted out of the northwest for many hours.

Meantime, back on the 23d, the 984-mb LOW was generating gale winds from 30° to 45°N and 35° to 55°W. The POSSEHL, at 34.3°N, 49.1°W, lucked out with 45-kt gales and 20-ft seas and swells. The worst was yet to come. The Greek motorvessel KARINA anchored off Flores Island, Azores, late on the 23d, after a cargo of steel plates shifted. Plates were resecured on the 25th, but moved again on the 27th, after encountering heavy seas.

Twelve hours later, at 0000 on the 24th, the LOW was at 41°N, 43°W, and moving northward. The DOCTOR LYKES, near 42°N, 46°W, and SEDCO J, at 47°N, 48.7°W, both were ravaged by 65-kt hurricane-force winds. The PHOTINIA, 360 mi west of the center, was pounded by 50-kt winds. A U.S. Coast Guard cutter also measured 50-kt winds. The seas were running about 15 ft, but, in the southern quadrant, were reported as high as 20 ft. At 1200 on the 24th (fig. 46), the DOCTOR LYKES was still being rolled by those 65-kt winds on her starboard side, as she continued her southwesterly course. The swells had picked up to 23 ft. The ATLANTIC MONTREAL, 220 mi south of the center, was battered by 50-kt winds, as was another ship off Cape Race.

The LOW was now moving north-northwestward, and, at 1200 on the 25th, was at 49°N, 50°W. Thirty-five- and forty-knot winds were reported in all quadrants.

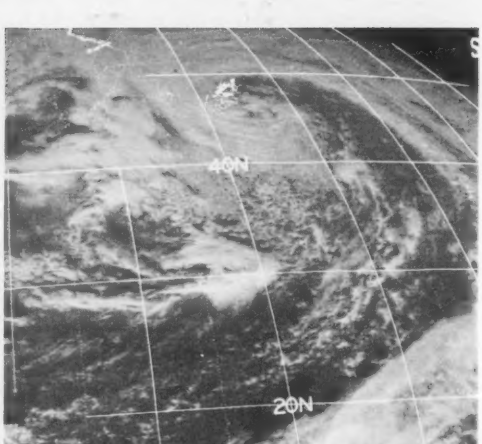

Figure 46.--The soft, fluffy appearance of the clouds hides the raging winds and seas that were battering the ships beneath them.

The storm was not dead, although it was weakening. The pressure had risen to 984-mb as it passed close to Ocean Station Vessel "B" at 1200 on the 26th. During the last 24 hr, the KOPER reported 50-kt storm-force winds near 47°N, 42°W; Ocean Station Vessel "B," 40-kt winds and 23-ft seas; and Kap Farvel buttoned down for 50-kt freezing winds, which later increased to 65 kt.

The LOW survived until 1200 on the 27th, when it was east of Hopedale. At that time, another LOW, which had moved out of Maine on the 25th and swept south of Newfoundland, turned northward. As nature decrees, the young replaced the old.

This new 985-mb LOW was near 52°N, 45°W, at 1200 on the 27th, and had no more mercy than the old. Kap Farvel was still measuring 55-kt winds. The OYOR, 100 mi to the south, was whipped by 60-kt winds and 33-ft seas. South of Argentia, the FNBA was battered by 45-kt gales. The area south of the tip of Greenland remained an area to avoid. Kap Farvel continued to report 50-kt winds until after 0000 on the 29th. The SVENDBORG, 50 mi south, was torn by 60-kt winds. On the 29th, a LOW moving up the St. Lawrence valley stole the circulation.

Casualties--The old culprit fog was involved in the collision of the 11,474-ton Malaysian BUNGA ANGSANA and the 11,535-ton Greek IKAROS in the River Scheldt on the 3d. The Brazilian NETUNO (7,759 tons) arrived at Montreal on the 9th with heavy weather damage. The 27,029-ton British motorvessel ATLANTIC CITY dragged anchor during heavy weather at Rotterdam on the 16th, and collided with the Singapore-registered MAHINDA (10,950 tons).

Rough Log, North Pacific Weather

October and November 1973

ROUGH LOG, OCTOBER 1973--Cyclone activity for the month was above normal. The general pattern closely resembled the climatological pattern, but there were a few significant differences. According to climatology, the major storm tracks come out of the west, over Sakhalin Island and southeast of Japan, toward the Near Islands, and into the Bering Sea. The major track then moves along the Aleutian Islands in the Gulf of Alaska, with a secondary track into the Bering Strait. Another primary track is located from the central ocean into the southern part of the Gulf of Alaska.

This month there were fewer storms out of the Sea of Okhotsk, but more from the area off Japan. The average path of these storms crossed the Aleutians east of the Near Islands and continued through the Bering Sea toward Alaska's west coast, thus the secondary track became the primary this month. Several cyclones formed in the central Pacific between 30° and 40°N, but in general dissipated prior to reaching the Gulf of Alaska or the North American west coast.

The Aleutian Low had two centers. The main one of 1000 mb was centered in the Gulf of Alaska, near 58°N, 147°W; the other was a 1009-mb center in the Sea of Okhotsk. The 1002-mb climatic Aleutian Low was located over Cape Newenham, Alaska. The 1019.8-mb Pacific High was approximately 2 mb higher, at 1022-mb pressure, and about 600 mi further west, near 34°N, 153°W. It also bulged farther to the north and northwest. This bulge resulted in the largest anomaly, a positive 9 mb, located near 50°N, 170°W. The two separate low centers were associated with a negative 6-mb anomaly in the Gulf of Alaska, near Yakutat, and a negative 3-mb center in the northwestern Sea of Okhotsk.

There were five tropical cyclones in the Pacific this month: hurricane Lillian in the eastern North Pacific, and typhoons Nora, Opal, Patsy, and Ruth in the western North Pacific. Climatological data indicated that two tropical storms, with one reaching hurricane intensity, can be expected in the east, and slightly less than four tropical storms, with almost three becoming typhoons, in the west.

The first week of the month, the North Pacific was dominated by a large HIGH over the central ocean, with a central pressure as high as 1044 mb. LOWs were confined to the sides of this large mountain of air. The formation of one of these LOWs was indicated on the 0000 chart of the 3d, by the 30-kt report of the HANYANG, near 33°N, 170°W. A 1014-mb LOW had formed near 32°N, 166°W. A weak cold front, which lay between the central Pacific HIGH and a 1034-mb HIGH off the U.S. west coast, was drawn into the LOW's circulation by 1200. Twenty-four hours later, the LOW had developed a good circulation, as a wave formed on the front.

Northwest of the center, the WAARDRECHT was being hammered on her starboard side by 45-kt winds, 16-ft seas, and 20-ft swells. The LOW was moving northeastward, but not for long. Late on the 4th, its path began to curve northward, then northwestward, as a cut-off LOW developed in the upper atmosphere. At 0000 on the 5th, the 500-mb upper air LOW was centered at 34°N, 162°W, and the surface 998-mb LOW was at 36°N, 162°W. Two ships on the north and northwest side of the LOW, which was pressing hard against the large 1037-mb HIGH, found 55-kt winds, 10- to 12-ft seas, and 21- to 30-ft swells. They were the AMERICAN CORSAIR, near 40.5°N, 163°W, and the ROBERTS BANK, near 42°N, 159.5°W.

On the 6th, the LOW had curved further toward the southwest as it followed the upper-air circulation. The strongest winds now being reported were 30 kt. The HIGH was breaking down and moving eastward, north of the southwestward-moving LOW. At 0000 on the 7th, the HOEGH ELAN was nearly in the center of the storm and being buffeted by 45-kt gales.

On the 8th, the storm was closing the circle and again moving northeastward, as the upper-air flow adjusted and the cut-off LOW dissipated. The surface LOW was filling as it lost its support and was surrounded on three sides by HIGHs. By the 0000 chart of the 10th, the LOW could no longer be identified.

This was a fast moving storm. It formed due east of Tokyo, as a wave on a front, on the 7th. This part of the front was located under the eastern side of an upper-air trough. As the previously referred to cut-off LOW broke down, the upper-air trough started moving eastward. Under this influence, the surface LOW developed rapidly. By 0000 on the 8th, the LOW had a 998-mb pressure and was at 39°N, 154°W. At 0000 on the 9th, it was near 47°N, 168°E, and 985 mb. Gale winds were blowing in the southern half. The HARUNA MARU and the HONG KONG MAIL both found 35-kt winds.

Twenty-four hours later, the center had raced to 55.5°N, 175°W, and the pressure was only 964 mb, deeper than some typhoons. The storm's forward speed had averaged over 30 kt, higher than most of the winds reported. The EASTERN BUILDER was 500 mi to the south, and really having a bad trip against 45-kt west winds, 20-ft seas, and 46-ft swells. At 1200 on the 10th, as the LOW moved toward Bristol Bay, the SANJIN MARU struggled with 55-kt winds. Twelve hours later, the WASHINGTON MAIL, south of the Alaska Peninsula, was in the 45-kt wind band. As the LOW moved across the peninsula into Cook Inlet, it split into two centers and then rapidly filled. The SWZL was still able to report 40-kt winds. The LOW remained in the Gulf of Alaska for 36 hr more, then was absorbed by another LOW, which had been following and moved around its periphery when it stalled.

This was another export from Japan. They were glad to see it go, as the dual wave system dropped heavy rain on most of the islands, particularly the northern ones. The southern wave is the one of concern here. It departed Nagoya on the 13th, at 1002 mb. As it moved eastward, the northern wave moved

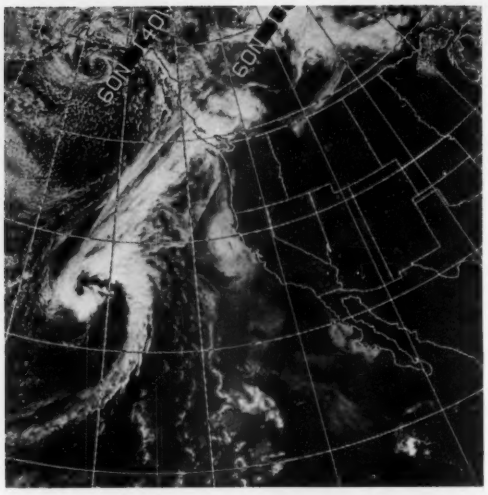

Figure 47.--The frontal system is well outlined as it stretches from the LOW in the Gulf of Alaska to another, almost due south, off the California coast.

northward. The associated front was nearly north-south oriented as a 1040-mb HIGH, centered just south of the Aleutians, held back its easterly movement. The wave moved northward along the front. At 1200 on the 15th, it was located near 44°N, 159°E. Between the front and the HIGH, the CHIKUZEN MARU had a breezy 35-kt.

On the 16th, the HIGH moved southeastward, and the LOW started curving eastward over the top and developing. By the 17th, it was over the Bering Strait. Usually this is the burial ground, but the cold weather rejuvenated this system. At 0000, the pressure had dropped to 984 mb. By 1200, the storm was 975 mb and moving southeastward across the Alaska Range. The HASHIMA MARU, at 57.5°N, 165°W, was hit by 50-kt gales, 25-ft seas, and 25-ft swells. On the 18th, the LOW was in the Gulf of Alaska, and the CHALMETTE, at 52°N, 162°W, was also slashed by those 50-kt winds and 26-ft seas. Not far away, the HOTAKA MARU was having 40-kt gales. The storm stalled on the 18th, near 57°N, 147°W (fig. 47), north of EB03. It was reporting 35-kt winds, as were half a dozen ships. At 1200 on the 19th, the NEVADA STANDARD, at 49.6°N, 134.3°W, found herself involved with 50-kt winds. To the west, Ocean Station Vessel "P" was concerned with 35-ft seas. The storm was persistent, but weakening. The USCGC JARVIS, south of Kodiak Island, was inspecting 45-kt gales and swells of 33 ft.

On the 21st, the storm began to drift southeastward, but not very far. It remained as an identifiable but impotent system until the 24th.

This storm formed at the point of occlusion of an old frontal system that came out of Asia. It found the fountain of youth over the Kuroshio Current off Japan on the 22d. Compared to other developing storms in this area, it contained high winds almost at inception. At 1200, the TOYOTA MARU No. 10 was headed southwestward into 60-kt storm winds and heavy rain, just ahead of the front.

The high-pressure areas had retreated far to the south, along approximately 30°N, so this was an easterly moving LOW. At 1200 on the 23d, the LOW was at 45°N, 176°E, with a pressure of 978 mb. A ship, the J-DJ, about 180 mi south of the center, was overtaken by 55-kt winds. Twelve hours later, the 966-mb LOW treated the ALBRIGHT EXPLORER to 50-kt winds at 44°N, 177°W. Another ship reported 40-kt winds about 90 mi northeast of the center.

At this time, a second LOW developed in the trough left behind as the original LOW moved eastward. On the 25th, the two LOWs were in trail south of the Aleutians. The younger was becoming the predominant one. On the 26th, the first LOW curved northwestward across the Alaska Peninsula and was lost in the wilds of Alaska. The new LOW was now a 978-mb circulation covering the ocean from the Canadian coast to the Kamchatka Peninsula. At 0600, the MAGELLAN MARU, near 41°N, 161.5°W, had 45-kt gales and 26-ft swells. The SILVERMAIN, at 40°N, 164°W, was whipped by 50-kt winds, 12-ft seas, and 36-ft swells. As the center moved into the Gulf of Alaska on the 27th, Ocean Station Vessel "P" measured 35-kt gales and 25-ft seas. At 1200 on the 28th, the LOW was wrecked on the rocky shore near Ketchikan, Alaska.

If it weren't late October and the latitude 35°N, this could have been considered a tropical easterly wave. A 1015-mb LOW formed in an inverted trough over the Yellow Sea on the 27th. A weak, diffuse system of LOWs and HIGHs had persisted over China for several days. The system consolidated and moved across the Sea of Japan on the 28th. By 1200, it was located near Hakodate, Hokkaido, Japan, and the pressure had dropped to 991 mb. Twelve hours later, it was really winding up, and gale winds were blowing. The JUNEAU MARU, just off the Kuril Islands, was swept by 45-kt winds blowing toward the islands. Gale winds were reported as far south as 35°N. At 1200 on the 29th, the 966-mb LOW was at 48°N, 151°W. The JUNEAU MARU, near 44°N, 151°E, was now suffering 50-kt southwesterly winds. The KATHRYN MARU, at 47°N, 155°E, and the SUZUKAWA MARU, at 45.6°N, 163.5°E, were both on the receiving end of 40-kt gales. Winds of 35 to 40 kt continued in the southern half of the storm, as it crossed the Kurils near 48°N. The LOW was now on an easterly track and the pressure was rising, as it moved under the upper-air ridge on the 31st.

At 0000 on November 1, the LOW again started to intensify. By 0000 on the 2d, it was located near 50°N, 172°W, at 992 mb. The KASHIMA MARU, in Bristol Bay, was riding out 40-kt gales. The path of the LOW was now northerly, and it entered the Bering Sea. The cold water north of the Aleutians was too much, and within 12 hr the LOW was no more.

Nora was spotted first about 200 mi northwest of Yap Island on the 2d. After meandering westward for 2 days, Nora turned northward and developed to typhoon strength on the 4th. She intensified rapidly. By the 5th, while heading west-northwestward, Nora became a supertyphoon; winds near her center reached 130 kt, with gusts to 160 kt. Early the next day, winds peaked

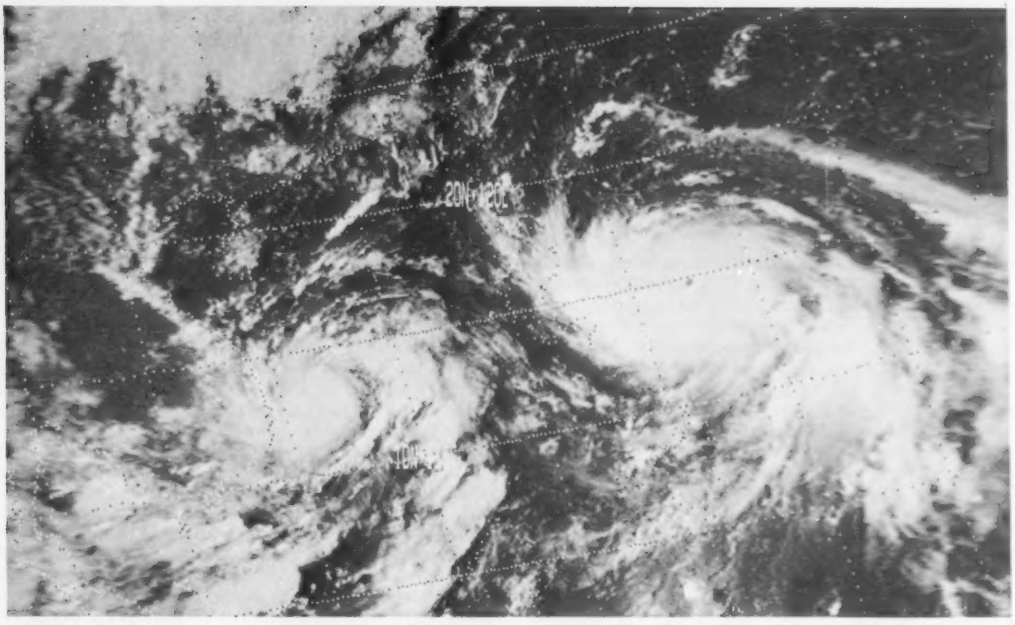

Figure 48.--Supertyphoon Nora (right) takes aim at the Philippines, while typhoon Opal hovers off South Vietnam on the 6th.

at 150 kt, with gusts to 180 kt, and Nora was on a beeline for Luzon (fig. 48). She was 400 mi away, but gale-force winds were not far off. As the supertyphoon came closer to the Philippines, it weakened somewhat. However, it is believed that the northeastern Luzon coast was battered by 140-kt gusts before Nora crossed the coast on the 7th. Winds, waves, and torrential rains caused extensive damage and were responsible for at least four deaths. Part of the Arnedo Dike, about 40 mi north of Manila, gave way, putting eight towns under water. After crossing the northeast tip of Luzon, Nora continued north-northwestward toward China. She moved through the Luzon Strait and the northern South China Sea, carrying winds only slightly above typhoon force minimum. Basco, on Batan Island in the Luzon Strait, measured 55-kt winds from the southeast at 1200 on the 8th. On the 10th, Nora crossed the China coast near Shan t'on.

Typhoon Opal was short lived. She appeared on the 4th in the South China Sea, some 430 mi east of Saigon. Heading northwestward, she reached typhoon intensity on the 6th, near 14°N, 112°E. At this point, Opal turned her 75-kt winds westward toward the central coast of South Vietnam. She crossed the coast as a typhoon late on the 7th.

About this time, Patsy was getting organized for her journey to the already-reeling northern Luzon. Patsy was first detected on the 6th, about 150 mi west of Guam. Heading west-northwestward, she reached typhoon strength on the 8th, near 14°N, 139°E. Patsy developed steadily. Winds climbed to above 90 kt on the 9th, and reached 130 kt, with gusts to 160 kt, on the 10th. The Japanese ship JMXU encountered 45-kt winds about 70 mi south of the center, at 0000 on the 10th. Patsy's intensity diminished rapidly as she neared Luzon on the 11th (fig. 49). Before the day

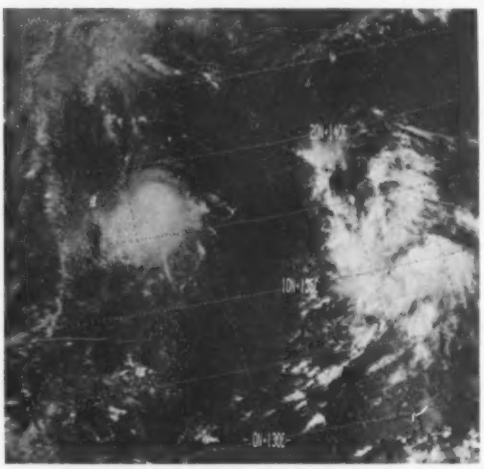

Figure 49.--Patsy poops out before reaching Luzon on the 11th; Ruth is beginning to form in that cloud mass to the southeast.

was through, she had dropped to tropical storm strength and turned northward to skirt the island. On the 12th, she turned toward the west and moved through the Babuyon Channel into the South China Sea. Patsy quickly weakened to a depression. In this stage, she traveled across the South China Sea and crossed the coast of South Vietnam near Da Nang on the 15th.

Typhoon Ruth was forming in the seas where Patsy developed as Patsy was approaching the Luzon coast on the 11th. Ruth's track was similar to, but south of, Patsy's until she reached the South China Sea. While Ruth did not become as intense as Patsy, she remained at typhoon strength from the 13th through the 18th. Her typhoon winds and torrential rains caused destruction in both the central Philippines and Hai-nan. At 0000 on the 15th, Laoag, Luzon, some 250 mi northwest of the storm's center, reported 45-kt winds. As Ruth neared Hai-nan, Hsi Sha Chou on Paracel Island reported winds from the south at 60 kt. Ruth moved on a west-northwesterly track for most of her life, cutting across central Luzon on the 15th, then turning northwestward on the 18th, to move through Hai-nan and finally into eastern North Vietnam and mainland China on the 19th. Ruth's central winds reached 70 kt on the 13th, in the Philippine Sea. After they diminished to minimum typhoon force over central Luzon, they increased to 85 kt on the 17th, in the South China Sea.

A large area of thunderstorms was followed on satellite pictures from about 300 mi south of the Gulf of Tehuantepec, on October 2, to 400 mi south of Manzanillo, at 0000 on the 5th. Reporting ships were generally 200 to 300 mi from the center, at the closest, but the KAPAA and the SANTA MARIANA helped locate the disturbance, which was to become hurricane Lillian.

Gradual intensification took place, and satellite pictures, at 0330 on the 5th, indicated a tropical storm had developed near 11°N, 103°W. The storm was moving west at 10 kt, a direction and speed that was maintained through 1800 on the 7th. At 0000 on the 5th, the storm passed about 120 mi south of the UNION VENUS, which reported 30-kt winds.

Few ships reported near the storm, but, at 1800 on the 7th, the characteristic cloud formation of a hurricane was visible in pictures. A more westerly course was followed after intensification occurred, but, as the hurricane moved over cooler waters southwest of the Lower California peninsula, dissipation was rapid. At 0000 on the 9th, it was a hurricane with 70 kt winds; by 0600, a tropical storm of 50 kt; by 1200, 45 kt; and, at 1800, only a swirl of clouds remained.

Casualties--Except for those already mentioned, the only other weather casualties involved a small ship. On the 6th, the MADELINE J. broke down 22 mi off the Oregon coast and had to be towed in by the Coast Guard. At the time, the wind was estimated by the Coast Guard at 50 to 60 kt, with gusts to 80 kt, and the seas, 15 to 20 ft.

ROUGH LOG, NOVEMBER 1973--The number of cyclone tracks was below normal and widely diffuse this month, except off the Asian coast. Another area that approached normal was a convergence of storm tracks near Queen Charlotte Islands. The normal concentration of storms along the Aleutian Islands was blocked by high pressure in that area.

The mean pressure pattern in the North Pacific also differed considerably from the climatological mean, as in the North Atlantic. This would be expected, as the weather is a continuous, rather than discontinuous, phenomenon. The meteorological situation at any one place affects and is affected by the adjacent areas. The Aleutian Low, normally 1000.4 mb and centered over the Pribilof Islands, was split into two centers. A 999-mb Low was over the Sea of Okhotsk, and a 1005-mb Low was about 250 mi west of Vancouver Island. The 1023-mb Pacific High was located near 33°N, 150°W. This was very close to the climatic position and only 2 mb higher, but the area enclosed by the lower value isobars was much larger. A 1025-mb High was centered over Yukon, Canada.

The largest anomaly was plus 17 mb, centered over Unimak Island in the Aleutians. There were three significant negative departures--a 10-mb, over the Sea of Okhotsk; a 9-mb, west of Seattle; and a 4-mb, in the south central ocean, about 27°N, 170°W.

During an average November in the western North Pacific, two or three tropical cyclones develop. One or two usually reach typhoon strength. This season, just three tropical storms developed in November. Most of the activity was confined to the South China Sea. Two affected South Vietnam, and one was destructive to the central Philippines.

There were many small transient LOWs across the North Pacific during the first week of this month. Most do not show on the storm track chart, as their lifespan was less than 24 hr. Several ships reported isolated instances of 35- to 45-kt gale winds.

This storm came into being between the 1800 chart of the 5th and the 0000 chart of the 6th. At the latter time, it was southeast of Tokyo Bay, near 34.5°N, 141°E. The 1011-mb LOW really moved out. In 24 hr, it had raced to 43°N, 154.5°E, and had dropped 19 mb, to a 992-mb center. As it continued deepening, it slowed in its northeasterly track. The pressure at 1200 on the 7th was 976 mb, near 47°N, 158°E. The JAPAN MAPLE was east of the center and the front, near 47°N, 164°E, when she ran into 50-kt winds. The ANNABELLA, about 100 mi north of the center, had 40-kt gales with heavy rain.

This LOW was a sprinter, rather than a long-distance runner. It slowed considerably by 0000 on the 8th, when it was located at 49.5°N, 160°E. The KANEYOSHI MARU was about 60 mi east of the center and was in a 60-kt storm. The wind was out of the southeast, but the 23-ft swells were out of the south. Further east, the UZZL, at 50°N, 168°E, was engulfed by 55-kt winds and 33-ft seas. Gales were reported ahead of and along the front as far south as 57°N. Lucky for the KANEYOSHI MARU that she was headed southwestward and the storm northeastward, for 12 hr later she was still reporting 50-kt winds.

As the LOW passed the tip of the Kamchatka Peninsula, it started to weaken and elongate, as another center developed to the north and it crowded against a 1039-mb HIGH, south of the Alaska Penin-

Figure 50.--The LOW has raced from its 1200 position to about 48°N, 170°E, at the time of this satellite pass. Winter is definitely indicated by the low sun angle and darkness in the higher latitudes.

sula. With that pressure configuration, the LOW regained its wind and sprinted through the Bering Sea into the Arctic Ocean. As it passed through the Bering Strait at 1200 on the 10th, there were no ships to report, but the weather station at Mys Navarin was frozen by 80-kt northwesterly winds, with a temperature of 2°F (-16°C). Mys Shmidta, on the Chuckchi Sea, had 60-kt winds at -2°F. The LOW moved across Point Barrow and, in the Beaufort Sea, hit Barter Island with 55-kt winds. It almost made it to the North Pole. On the 15th, it was lost in the Arctic wastes near 83°N, 90°W.

This LOW formed in a weak area of a trough left behind by several previous LOWs, moving through the Sea of Japan into the Sea of Okhotsk. At 0000 on the 19th, it was 998-mb at 38°N, 144°E, off Honshu. By 1200 on the 20th, it was near 44°N, 162°E, at 972 mb (fig. 50). Six hours earlier, it had passed south of the WRANGELL MARU, and now treated her to 65-kt northerly winds, near 43.3°N, 157°W. The GOLDEN GATE BRIDGE was south of the LOW, at 38°N, 162.5°E, and had 45-kt gales, along with 20-ft seas and swells. The BRIDGE was headed westward at 15 kt.

The LOW continued its northeasterly track into the Bering Sea, with reports of 35- to 40-kt gales common. At 1200 on the 21st, the LOW was a 962-mb storm near 55°N, 179°E. Mys Navarin was blasted again by 60-kt winds off the gulf--not exactly ideal conditions. Just to the south, a ship (the -GKX) was blown by 45-kt winds. To the south of the LOW, the DATAN MARU found 40-kt winds. Twelve hours later, other weather stations in the Bering Strait were reporting 50-kt winds. The GOLDEN ARROW, at 55°N, 180°, battled 45-kt winds. At 1200 on the 22d, the storm passed near the ILLARION RYABIKOV and treated that ship to 45-kt gales, 15-ft seas, and 26-ft swells. St. Paul Island was lashed by 40-kt winds. On the 23d, another LOW approached from the southwest and absorbed the storm on the 24th.

As the month progressed, the area of cyclogenesis moved eastward. At 0600 on the 22d, a LOW formed

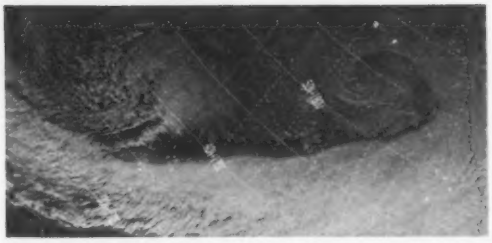

Figure 51.--The clouds break off sharply behind the front. This is generally an indication of a strong storm.

near 40°N, 158°E. The pressure in the area was already low, so the pressure at 1200 was 991 mb. The HOROMYA was well to the southwest of the center, near 35°N, 151°E, and on a 45-kt isotach, with 20-ft swells. At 0000 on the 23d, the developing 978-mb LOW treated the PACIFIC LOGGER to 45-kt winds, in an area well south of the center along 35°N. Two fishing boats sank in the stormy waters of the Sea of Japan, one on the 22d and the other on the 23d.

Late on the 23d, the LOW had moved into the Bering Sea and was a 949-mb whirlpool (fig. 51), near 56°N, 172°W, after absorbing the previously described circulation. Winds of 40 to 45 kt were no oddity. The SPRUCE, 400 mi to the south, was bucking 50-kt winds. The storm passed along the southern Alaskan coast on the 25th, and filling commenced, but did little to slacken the offshore winds. The KATHRYN MARU, at 54.2°N, 147°W, was beset by 60-kt storm winds. Ocean Station Vessel "P," to the south, was slightly better off with 45-kt winds, but both had 20-ft seas. Late on the 25th, the LOW foundered on the mountainous Alaska coast.

A series of minor troughs were moving around the edge of the major trough and cyclonic circulation which was located in the Bering Sea. This one appeared over the southern tip of Sakhalin Island at 1200 on the 22d. A closed LOW with an obvious center appeared on the 1200 chart of the 23d, near 42°N, 152.5°E. It was also obvious to the JAPAN AMBROSE and the SHOGEN MARU as they experienced 35- and 40-kt winds south and west of the LOW, respectively. The LOW quickly developed and raced along 40°N. At 0000, it hit the JGFM with 50-kt winds, the PACIFIC LOGGER with 45-kt winds, and the NICHIHO MARU with 40-kt winds, south of the center. The LOW was moving so fast the seas and swells had built to a maximum of 18 ft.

On the 25th, the LOW, now at 982 mb, turned northeastward. The HAKONE MARU had been on a collision course with the center, and the two must have met about 1200 on the 24th, but there was no report plotted for that time. At 0000, she reported 45-kt southwesterlies, 21-ft seas, and 26-ft swells.

This LOW was a long-distance runner, as it was in the Gulf of Alaska by 0000 on the 26th. Ship reports in its vicinity were scarce. On the 27th, it turned southeastward, to parallel the North American coast. The pressure in the LOW had increased, and the gradient relaxed on the 26th, but, on the 27th, it gained renewed vitality. At 1200, the INDIAN MAIL was south of Kodiak Island and blasted by 45-kt winds

from the northwest. On the outer fringe of the storm, near 49°N, 158.5°W, the HOYO MARU also found the 45-kt wind band. Late on the 27th and on the 28th, the LOW paused and circled, while deciding on its next direction. The NNCR, at the mouth of the Columbia River, reported 35-kt winds off the land.

The LOW moved toward the south, then eastward, and then northeastward, while rapidly deteriorating. It finally dissipated on the mountains of British Columbia on December 2.

This LOW came out of Manchuria and crossed through the La Perouse Strait on the 27th. At the same time, another LOW was forming in the vicinity of 32°N, 163°E. Their destinations were to be the same. The Manchurian LOW moved up the Kuril Islands and was well behaved until 1200 on the 28th. It was then located at 48°N, 157°E. Near the triple point of the occlusion (43°N, 160°E), two ships reported 45-kt winds. They were the SPRUCE and the JIOW. At 1200 on the 29th, the LOW combined with the one out of the south, near 54.5°N, 164°E, into one 961-mb LOW.

At 0000 on the 27th, this LOW was near 29.5°N, 170°E (fig. 52). The MONTIRON, at 35.5°N, 168.5°E, was headed west with 60-kt northerly winds, 34-ft seas, and 30-ft swells. This LOW rapidly deepened, and, at 1200, was 984 mb. A ship reported 50-kt winds near 32.5°N, 177.5°E, about 120 mi southeast of the LOW's center.

On the 28th, the LOW turned northward and its circulation expanded. There were gale-force wind reports all around the storm. The PACIFIC BEAR, northeast of the center and north of the warm front, near 43.5°N, 179.5°E, reported the sky obscured and 50-kt winds. At 1200, the LOW was at 40.3°N, 174.5°E, and 979 mb. The PACIFIC BEAR was still bucking 45-kt winds and seas to 20 ft. At 0000 on the 29th, the major circulation of the two LOWs had combined, but two centers were still present. The KATHRYN MARU, far to the north at 53.8°N, 179.7°W, had 50-kt southeasterly winds. Northwesterly 50-kt winds were reported in the Kuril Islands. At 1200 on the 29th, the two centers had combined into a 961-mb LOW. The URBW was battered by 50-kt winds in the Sea of Okhotsk.

On the 30th, the JDND, near 47°N, 161°E, suffered 50-kt winds, with 20-ft seas and swells. Ostrov Paramushir was blown by 55-kt winds, and that lovely place, Mys Navarin, was blasted by 80-kt wind-driven snow. On December 1, the LOW started breaking down, as minor LOWs formed or entered the major circulation. Late on the 1st and on the 2d, the LOW was stationary, and, by the 3d, one of the minor LOWs became the major force.

Tropical storm Sarah had a brief life in the South China Sea. She can be traced back to just east of Mindanao, where she began life as a tropical wave, along the Intertropical Convergence Zone, on about the 6th. The wave moved westward across the Island and into the South China Sea. It wasn't until the 10th, about 90 mi east of Nha Trang, South Vietnam, that Sarah became a tropical depression. She barely made it to tropical storm strength before brushing the coast of South Vietnam and weakening later on the 10th.

Some 4 days later, Thelma developed in this same area, She was detected as a tropical storm, early on the 15th, near 10°N, 110°E. A few hours later, the NISSHO MARU encountered 30-kt winds about 100 mi southeast of the storm's center. However, Thelma was too close to land to develop. She moved ashore south of Saigon on the 16th, as a tropical depression. The depression crossed the Delta and moved into the Gulf of Siam on the 17th. She finally dissipated over southern Thailand on the 18th (fig. 53).

Tropical storm Vera appeared on the 20th, just east of Samar in the Philippine Sea. It took her 2 days to cross the Islands. Her 40-kt winds and torrential rains caused flooding that destroyed homes and crops. At least 33 people died, including 23 who drowned in floods in Mindanao. Winds increased to 45 kt, as Vera moved over the South China Sea on the 22d. She headed northwestward toward Hai-nan (fig. 54). Vera weakened to depression strength on the 25th, southwest of Hai-nan.

Casualties--Several ships had weather damage, but the exact locations and dates were not available. They were the 17,355-ton Greek tanker MESSINIAKI CHARA, Honolulu for Singapore; the 9,951-ton Greek motorvessel GRIGOROUSSA, due Yokohama; and the Cypriot motorvessel MARICHANCE, Pascagoula to Cochin. A supply vessel named BOLD VENTURE sank during heavy weather in the Persian Gulf on the 6th.

Figure 52.--The cloud pattern around this LOW is not so well organized, but the strong winds are there nevertheless.

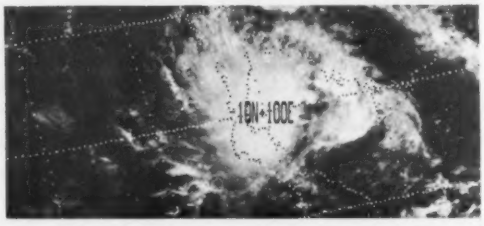

Figure 53.--Thelma was given final rites shortly after this portrait, shot on the 8th.

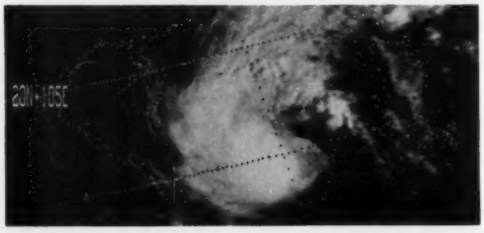

Figure 54.--Tropical storm Vera begins to merge with a broad stationary frontal system on the 24th.

Marine Weather Diary

NORTH ATLANTIC, JANUARY

WEATHER. January is generally characterized by rough weather over the middle and northern latitudes of the North Atlantic. LOWS frequently become deep, and associated winds often reach gale and sometimes hurricane force. The Icelandic Low (1000 mb), centered off the extreme southeastern tip of Greenland, is deeper than at any other time of the year. The Azores-Bermuda High with a central pressure of about 1023 mb covers a band from the western Mediterranean Sea west-southwestward to the waters northeast of the Bahamas.

WINDS. North of 40°N, the prevailing winds are westerly over most of the ocean. Over the Norwegian Sea and the North Sea, winds from the southerly quarter prevail. The average wind speeds are predominantly force 4 to 6, except up to 1,200 mi south and east of the southern tip of Greenland and over the Labrador Sea where they reach force 5 to 7. Between 25° and 40°N, the wind direction is from the southwest quarter of the compass over the main body of that portion of the Atlantic, mostly easterly over the Gulf of Mexico, variable over the waters east of Florida, and northerly or northeasterly from west of the Iberian Peninsula to the Canary Islands. Westerlies still dominate over the Mediterranean Sea. Force 3 to 4 winds are the most common except off the coast of the middle Atlantic United States where force 4 to 6 winds prevail. From the Equator to 25°N, the "northeast trades" persist; more than 65 percent of the time wind speeds range from force 3 to 5, except south of 10°N where these winds blow more than 50 percent of the time.

GALES (winds force 8 and higher) occur in 10 percent or more of the observations north of 35°N over the western part of the ocean and north of 40°N over the eastern part. The Mediterranean Sea hosts 10-percent frequencies out to 150 mi from the Gulf of Lions, over the northern Adriatic Sea, and over most of the Aegean Sea. The highest frequency over all North Atlantic waters, 30 percent, is found over a small area centered at about 58°N, 30°W, over a narrow belt off the southern tip of Greenland between 38° and 52°W, and (because of the mistral) over the Gulf of Lions.

EXTRATROPICAL CYCLONES. During the winter months (December, January, and February) LOWS form most frequently in a band 150 to 250 mi wide stretching from the North Carolina-South Carolina border northeastward to about the latitude of Cape Cod. This is part of a large area of cyclogenesis that extends from the Gulf coast of the United States northeastward to the Bay of Fundy. Other principal areas of cyclogenesis lie over the western half of the central ocean between Newfoundland and the British Isles, over most Icelandic coastal waters, over the inland waters east of the North Sea except the Gulf of Bothnia, and over the Mediterranean from the Gulf of Lions southeastward to the toe of Italy and then northward to the Yugoslavia coast. Cyclogenesis is more concentrated around the waters on both sides of central Italy than anywhere on the North Atlantic during winter with the exception of the band off the United States Atlantic coast. In January, primary storm tracks run from the Carolina capes to Cape Race and from Lake Superior to Cape Bauld. After reaching Newfoundland, cyclones either head northward to the Davis Strait or the Denmark Strait or northeastward to Iceland. Primary storm tracks are also present off the northern Norwegian coast, over the Mediterranean from the Gulf of Genoa to Cyprus, and over the eastern Great Lakes where they join the track toward Newfoundland.

SEA HEIGHTS greater than 12 ft occur 10 percent or more of the time north of 33°N over the western North Atlantic and north of 42°N over eastern waters. Frequencies greater than 10 percent also exist in a small area near Barranquilla, Colombia, and on the Mediterranean between Menorca and Sicily (not including the waters surrounding Corsica), south of Greece and west of Crete, and on the northern Aegean Sea. A large area of frequencies greater than 30 percent stretches from south of Iceland to west of Ireland to east of the Grand Banks and then northward to the waters southwest of Greenland and south of the waters between Greenland and Iceland. Smaller areas of similar frequency are found on the Denmark Strait and west of northern Norway near 67°N, 10°E. The frequency of sea heights greater than or equal to 12 ft decreases to less than 10 percent over a large portion of the Norwegian Sea north of 67°N between 5°E and about 13°W.

VISIBILITY less than 1 mi is noted in more than 10 percent of the observations from Cape Sable eastward to the Grand Banks and northward to Cape Mercy, over the Denmark Strait and the northwestern portion of the Norwegian Sea, and over the southern portion of the North Sea. The frequency increases to more than 20 percent in the Resolution Island area and over the Norwegian Sea north of about 70°N.

NORTH PACIFIC, JANUARY

WEATHER. The most severe weather of the year generally occurs in January over the middle and northern latitudes of the North Pacific. The circulation over the ocean is controlled mainly by the major centers of action--the Aleutian Low, the subtropical High, and the Siberian High. All except the subtropical High are near or at their peak seasonal development. The Aleutian Low, with a central pressure of 1000 mb, is southeast of Kamchatka near 50°N, 165°E, while the axis of the Pacific subtropical ridge exceeds 1021 mb from about 30°N, 135°W, east-northeastward to the State of Wyoming. The wind regime near the Asiatic coast from the Korea Peninsula to the South China Sea is controlled principally by the clockwise flow around the Siberian High (1036 mb), situated over Asia near 49°N, 96°E.

WINDS. Westerly winds prevail over much of the ocean north of 30°N and west of 180°. Northerly winds dominate the East China Sea. Winds are variable over the western Aleutians, southeasterly over

the central Aleutians, and northeasterly near the Pribilof Islands. From the Gulf of Alaska southward to near 40°N and east of 180°, winds are mostly westerly to southerly, although other directions are common during the frequent passage of LOWS. Over the extreme northern Gulf of Alaska, the prevailing winds are easterly, and northerly winds are very pronounced over the Bering Sea north of 60°N. The average speed of winds north of 30°N is force 4 to 6, although southeast of Kamchatka the wind blows at force 7, 21 percent of the time. The "northeast trades" extend northward to near 25°N over most of the western and central ocean and to 30°N over eastern waters; south of 20°N, these winds are very steady. The wind speeds in the trades range from force 3 to 5. The "northeast monsoon" is steady over the South China Sea and the Philippine Sea south of 30°N and west of 150°E. Winds are quite variable over the eastern North Pacific between 30° and 40°N, southwesterly over the east-central ocean between 25° and 40°N, and variable over west-central waters between 25° and 30°N and 150°E and 180°. Wind speeds over the above three areas are usually force 4. Northerly winds predominate over the Gulf of Tehuantepec, and in 65 percent of the observations they range between force 2 and 6.

GALES. The frequency of gales near and above 10 percent affects most noncoastal areas south of the Aleutians and north of a line from the waters southeast of Honshu to a point south of the Queen Charlotte Islands and west of Washington State. A maximum incidence of over 20 percent is found over a relatively large region southeast of Kamchatka, over a smaller area east of northern Honshu near 39°N, 154°E, and south of the Gulf of Alaska near 50°N, 145°W. Gale-force northerly winds are encountered more than 10 percent of the time by vessels plying the Gulf of Tehuantepec off southern Mexico. These violent squally winds occur when strong northers from the Gulf of Mexico funnel across the isthmus to the Pacific. In extreme cases, they may be felt more than 200 mi out at sea.

EXTRATROPICAL CYCLONES. Principal areas of cyclogenesis during winter are found from Taiwan on the southwest to the northern Kurils and lower Sakhalin on the northeast and from just north of Marcus Island on the southeast to the western shore of the Sea of Japan on the northwest. The Yellow Sea and Korean coastal waters are not included in this vast region of cyclogenesis. Other smaller areas of cyclogenesis lie over the Pribilof Islands, the Gulf of Alaska, off the North American coast from the Queen Charlotte Islands southward to northern California, and over the east-central ocean about midway between the Aleutian and the Hawaiian Islands. The migratory LOWS move mostly northeastward from the East China Sea and Hokkaido to the western Aleutians and then east-northeastward to the Gulf of Alaska. Other primary tracks approach the Gulf of Alaska and Vancouver Island from the southwest.

TROPICAL STORMS are infrequent in January. On the average, two can be expected every 5 yr over the western North Pacific. Most of these storms develop between 6° and 10°N and west of 150°E and move toward the southern half of the Philippines. Three out of every five January tropical storms achieve typhoon strength.

SEA HEIGHTS greater than 12 ft occur more than 10 percent of the time in an area extending northward from 30° to 35°N to a line drawn from Kodiak Island to the central Aleutians and then to the southeastern waters of the Sea of Okhotsk, and westward from a line 700 mi off the coast of southeastern Alaska and 500 mi off the Oregon coast to 150°E.

VISIBILITY less than 2 mi occurs in 10 percent or more of the observations over an area of the eastern North Pacific between 40° and 50°N and 141° and 162°W, and northwest of a line drawn from Hokkaido to the western Aleutians and then northeastward along the Aleutian chain to the Alaska Peninsula and Cape Avinof. A maximum frequency of over 30 percent encloses a small area over the Okhotsk Basin southwest of Kamchatka.

NORTH ATLANTIC, FEBRUARY

WEATHER. Usually the weather over the North Atlantic during February is a continuation of the storminess characteristic of January, and there are years when February weather is the most severe of winter. The average pressure distribution remains quite similar to that of January. The Icelandic Low fills to 1004 mb, and the central pressure of the Azores High drops to 1021 mb near 32°N, 22°W. The 1020-mb Bermuda High lies near 27.5°N, 48.0°W. This reduction in the average north-south pressure gradient is caused both by LOWS being less intense on the average during February, and by the more frequent appearance toward the advent of spring of a blocking HIGH at higher latitudes.

WINDS. The prevailing wind pattern shows only a slight change from January. North of 40°N, the southerly winds over the North Sea have veered to westerly while the southerlies over the Norwegian Sea have become variable. Southerly winds are now found south of Iceland near 60°N, 20°W, and winds well west of the Bay of Biscay have become variable. Between 25° and 40°N, there is close agreement except that the southwesterly winds off the middle Atlantic coast of the United States are now northwesterly. Wind speeds are also nearly a carbon copy of those in January. The only exceptions are that between 25° and 40°N, the winds between 30° and 60°W have increased from about force 4 to force 4 to 6, and north of 40°N it is not as windy over the Baltic Sea.

GALES. The frequency of gales decreases near Iceland, the North Sea countries, the Mediterranean Sea, and the Baltic Sea. An increase in gale frequency is noted over the Davis Strait and the Bay of Biscay. The 30-percent frequency line vanishes over all areas previously encompassed by it during January. Lines of 20-percent frequency enclose these areas. Otherwise, the frequency of gales is about the same as in January.

EXTRATROPICAL CYCLONES. The only significant change in storm tracks this month is an increase in northeasterly tracks over the waters between the Grand Banks and 35°W.

SEA HEIGHTS. Seas 12 ft or higher can be expected

10 percent or more of the time north of a line from a couple of hundred miles east of Cape Hatteras to Cape Finisterre, Spain. On the Mediterranean, 10-percent frequencies lie inside an ellipse stretching from Barcelona, Spain, to Crete and then northwestward to Sicily, Sardinia, and the Gulf of Genoa. Another small area of 10-percent frequency lies between Crete and Turkey. The coast of Colombia still hosts a 10-percent line near the same area as in the previous month, but areas of 10-percent frequency no longer exist over the Baltic Sea or the Davis Strait. That portion of the Norwegian Sea with a frequency of sea heights greater than or equal to 12 ft of less than 10 percent extends farther south and west than it did in January. The highest frequencies, greater than 30 percent, are found over a triangular area between 57°N, 43°W; 45°N, 42°W; and 61°N, 13°W; and over the Denmark Strait.

VISIBILITY. The frequency of low visibility (less than 2 mi) reaches 10 percent or more from Halifax, Nova Scotia, northeastward to a point near 50°N, 40°W, and then northwestward to near Cape Mercy. It also reaches 10 percent on the southeastern North Sea and over the waters around the Faeroe Islands and eastern Iceland. The frequency increases to more than 20 percent inside a coastal region from Cape St. John, Newfoundland, to Resolution Island and then southward to Ungava Bay, and over the Norwegian Sea north of about 72°N.

NORTH PACIFIC, FEBRUARY

WEATHER. February weather in general is equally as rough as that of the preceding month over the middle and higher latitudes of the North Pacific. The average central pressure of the Aleutian Low (1000 mb) and the subtropical High (1021 mb) remains essentially the same as during January. The center of the Aleutian Low is displaced about 300 mi east of its January position, and the subtropical High (no longer an elongated ridge) is centered near 31°N, 138°W.

WINDS. The average direction and strength of the winds over the North Pacific during February conform closely to the mean January distribution. However, the winds over the central Aleutians have become more variable and the "northeast trades," although their average speed as a whole has lessened, are better established over the west-central ocean. The winds southeast of the Kamchatka Peninsula are not as strong either, reaching force 7 only 8 percent of the time. Over the Gulf of Tehuantepec, 71 percent of the winds are now force 2 to 6.

GALES. The areal distribution and percentage frequency of gales are also practically identical to the preceding month with a few exceptions. The 20-percent areas south of the Gulf of Alaska and east of northern Honshu increase in size. The other 20 percent area southeast of Kamchatka shrinks in size and moves farther southeastward to a position near 42°N, 173°E. Gales are not as numerous (less than 10 percent of all observations) over the waters south of the eastern Aleutians and the southwestern tip of the Alaska Peninsula and west of Washington State. The eastern extremity of the 10-percent line is west of Vancouver Island this month. Over the Gulf of Tehuantepec, gales are now reported in less than 10 percent of all observations.

EXTRATROPICAL CYCLONES. There is less of a concentration of storm tracks over Hokkaido and the southern Kurils in February than in January; secondary tracks converge 350 mi east-northeast of Hokkaido and head east-northeastward toward the Rat Islands in the western Aleutians. A primary track extends northeastward from the East China Sea to the waters south of the western Aleutians and then runs parallel to that island chain to the Gulf of Alaska. The passage of LOWS over the Gulf of Alaska along the track described above and the one entering from the southwest is more confined to the western portion than in the previous month. The storm path approaching Vancouver Island from the southwest does not contain a maximum concentration of individual cyclones until it reaches a point 500 mi from that island. In January, cyclones become concentrated along this path when 1,000 mi from Vancouver Island.

TROPICAL STORM activity is at the annual minimum during February. On the average, one can be expected every 4 yr over western waters. As in the other winter months, the principal region of cyclogenesis is east of the central and southern Philippines. Two out of every seven February tropical storms has reached typhoon intensity in the past.

SEA HEIGHTS. Seas of 12 ft or more are encountered from 10 to 20 percent of the time over most of the ocean area between latitudes 30° and 52°N from 140°W to 145°E. A small area with a similar frequency lies over the waters bounding Taiwan where the "northeast monsoon" blows strongly and steadily. Areas of 20- to 30-percent frequency extend between latitudes 44° and 49°N from 172°E to 153°E, and farther southeast 100 to 200 mi around a line drawn from 35°N, 165°E to 40°N, 175°W.

VISIBILITY. Areas of limited visibility (less than 2 mi) occur in more than 10 percent of the observations north of a line drawn from the Yellow Sea through the Sea of Japan, south of Hokkaido, and then east-northeastward to the Alaska Peninsula. A maximum frequency of over 30 percent surrounds the waters around Ostrov Paramushir, south-southwest of Kamchatka.

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ADDRESSES OF NATIONAL WEATHER SERVICE PORT METEOROLOGICAL OFFICES

NOAA National Weather Service Port Meteorological Offices have personnel who visit ships in port to check and calibrate barometers and other meteorological instruments. In addition, port meteorologists assist masters and mates with problems regarding weather observations, preparation of weather maps, and forecasts. Meteorological manuals, forms, and some instruments are also provided.

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